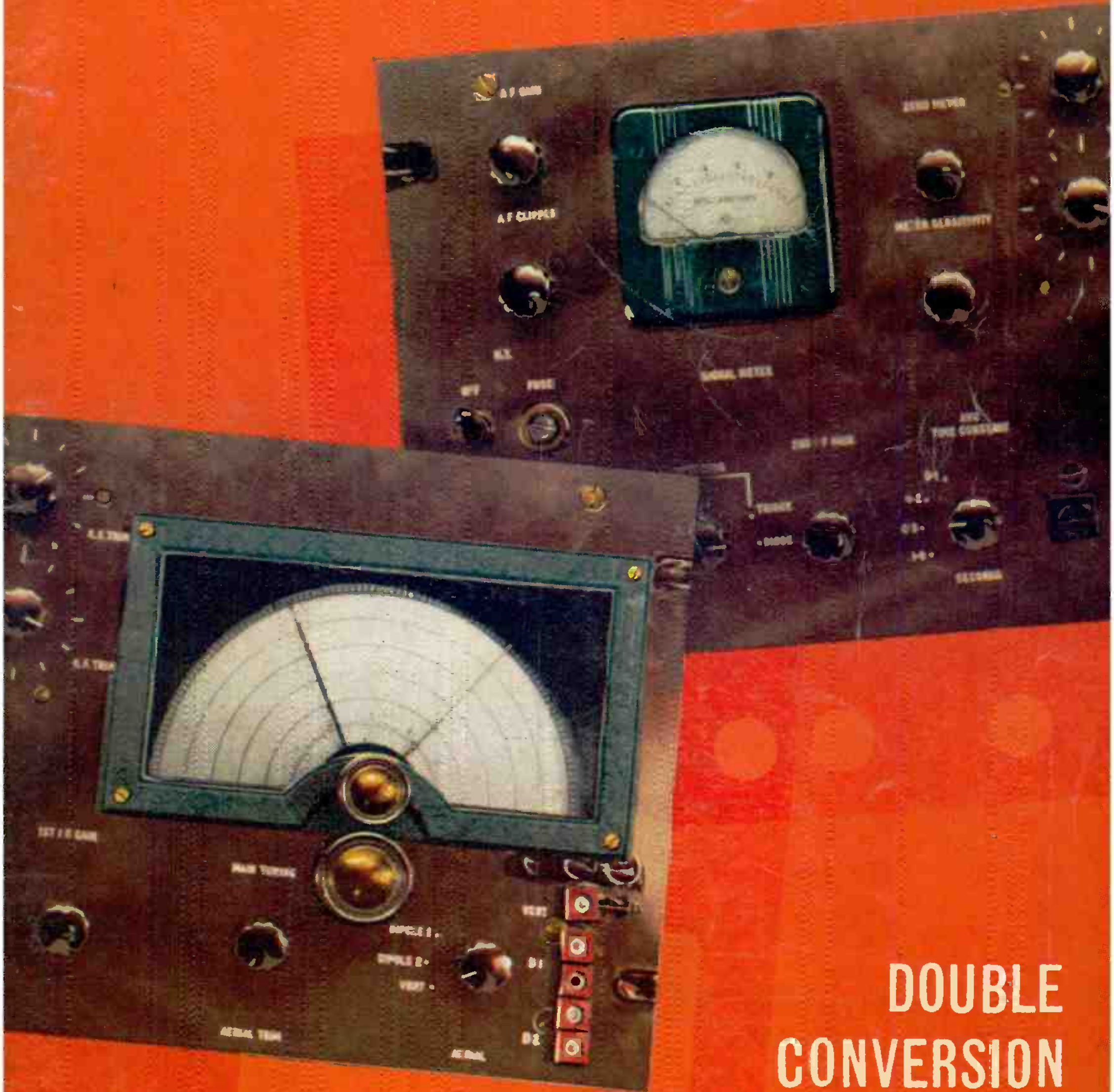
MAY 1963

Practical WIRELESS

2/-



DOUBLE CONVERSION COMMUNICATIONS RECEIVER

Tubes

HIGHEST QUALITY—
COMPARE OUR PRICES

Carr. & Ins. 12/6

		GUARANTEED 6 Months	GUARANTEED 12 Months	NEW TYPES
MOST MULLARD, MAZDA, COSSOR, EMITRON, EMI-SCOPE, BRIMAR, FERRANTI TYPES, PROCESSED IN OUR OWN FACTORY	12in.	£2. 0.0	£3. 0.0	MW 31/74 £3.15.0
	14in.	£2.10.0	£3.10.0	MW 36/24 £4.15.0
	15–17in.	£3. 5.0	£4. 5.0	CRM 172 MW 43/64 £6.0.0
	21in.	£3.15.0	£5.15.0	

VALVE HOLDERS. B7G 6d. ea., with Screen 8d. ea., B9A 6d. ea., with Screen 8d. ea. Int. Octal 6d., Mazda Octal 4d., B8A 6d. (less 15% in dozens).

SPECIAL TEMPORARY OFFER. Due to huge Bulk Special Purchase we are offering MW 31/74 Tubes at the unrepeatable price of 29/-. MW 36/24 ditto, 39/-. P.P. 12/6. The above are guaranteed for 6 months.

P.M. SPEAKERS, 3Ω Top Makes. 6½in. 8in. **7/6** 5in. 7 x 4in. **8/6**

VALUE!

4 watt AMPLIFIERS

excellent amplifier with high gain preamp stage, 10F3 driving 10P14 output stage, complete with 8in. speaker. In attractive 2-tone case. Tone control, negative feed-back, ready for immediate use, individually tested. Amazing volume and clarity, ideal for guitars, record players, p.a. in small halls, baby alarms etc. Easily worth £5. Our price whilst stocks last. Carr. Packing, etc. 7/6. 45/-

CO-AX, low loss, 6d. yd., 25 yds., 11/6, 50 yds., 22/-. 100 yds., 42/6. Co-ax Plugs 1/3. Wall outlet boxes 3/6.

4-SPEED RECORD PLAYERS Latest Turntable, together with lightweight Staar Galaxy dual sapphire crystal turnover pick-up head Amazing value (pick-up only 19/-). £3.10.0. Carr. 3/-.

SILICON RECTS.

250V 500mA standard TV replacement Top quality 8/6 (3 for 24/-).

COSSOR D.B. SCOPE TUBES. Type 09D Split Beam. Ideal for building your own quality oscilloscope. **55/-**

4ft. FLUORESCENTS

G.E.C. SLENDORA. 40 watt elegant slimline complete with starting equipment. Beautiful contemporary finish. P. & P. 4/-. **45/-**

100 RESISTORS 6/6
Excellent. Sizes ¼–3 watt.

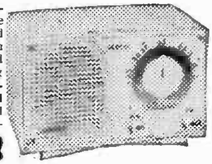
100 CONDENSERS 10/-
Miniature Ceramic and Silver Mica Condensers, 3 pF to 5,000 pF. LIST VALUE OVER £5.

TAG STRIPS. From 3-way to 12-way. The best and cheapest way to buy! Mixed parcels of 25— **3/9**

12 POTS. Popular values. 5K to 2 Meg. Unused, mixed, pre-set, long sp., switched, etc. **4/6**

CONDENSERS. 25 Mixed, Electrolytic. Many popular sizes. List Value £5. Our Price **10/-**

ALL WAVE RADIOS



VERDI 55. FULL 5 VALVE SUPER-SENSITIVE SUPERHET. Really attractive high quality modernistic pastel and gold cabinets. Very compact. Wavebands 18–50m 180–550m, 700–2000m, ferrite aerial and throwout aerial. Smooth slow motion tuning High flux 4in. speaker. **AMAZING S.W. PERFORMANCE. CLARITY. VOLUME.** Standard miniature valves. Easily serviced, standard layout. Truly unusual value and UNREPEATABLE absolutely complete with guarantee and circuit. Tax paid. **7½ Gns.!**

VERDI 54. As above but without short-wave. **6½ Gns.** Post Free

HIGH STAB. RESISTORS. 250,000 in stock including 1% Tolerance. 100's of values. A must for high grade equipment, our selection 50 for 8/-. Your selection (min. qty. 4) 6d. ea.

P.V.C. CONNECTING WIRE. 100 yd. 30 mill: Special Price 7/6. 200 yd. 30 mill: special price. 12/6. 25ft. Coil, 1/-. 5 Coils different colours, 4/-. Connecting flex. Prices as above.

14in. TVs. Carr. 12/6. With CRM 141 Tubes. Absolutely complete, tested for raster. Famous make, large purchase enables us to offer them at **£4.19.**

TELEPHONE C.O.D. ORDERS DISPATCHED THE SAME DAY.

3 VALVE AMPLIFIERS. Kit of new parts, consisting chassis mains and output transformers, valves (P61, 6G6G, 6X5G) and all components. With full instructions for making high gain amplifier with separate base and treble controls, negative feedback, etc. Truly unusual value at **29/-**

RECTIFIERS. 250 v., 80 mA, 5/-; RM2, 6/9; RM3, 7/6; RM4, 19/6; RM5, 19/6; 14A86, 17/-; 14A97, 19/6; 14A100, 19/6; 16RC1-1-16-1, 7/9; 18RA1-1-1-16-1, 6/-; 18RD2-2-8-1, 14/-; 14RA1-2-8-2, 17/-; 14RA1-2-8-3, 20/-.

TRANSISTOR SNIPS

Huge reductions. Red Spot standard L.F. type now only 1/6; White Spot R.F., 2/-. Mullard Matched Output Kits (OC81D and 2—OC81's). 12/6. Receiver Kits. OC44, OC45(2), OC81D, OC81(2), six transistors. **25/-**

GUARANTEED
★ VALVES ★

by return of post

THE MOST ATTRACTIVE COMPETITIVE VALVE LIST IN THE COUNTRY

All valves are new and unused unless otherwise advised

POST	3 MONTHS GUARANTEE	FREE TRANSIT INSURANCE.
1 Valve 6d., 2-11, 1/-. FREE for 12 or more valves.	In writing with every valve.	Satisfaction or Money back Guarantee on Goods if returned within 14 days.

OZ4	4/6	6K7	5/9	20D1	8/9	DL82	9/-	EZ40	6/6	U22	6/9
1A7GT	9/6	6K7G	2/-	20F2	9/6	DL92	5/-	EZ41	6/9	U24	12/6
1C5GT	7/6	6K7GT	4/6	20L1	16/-	DL94	6/6	EZ80	5/9	U25	10/6
1D5	7/-	6K8G	5/-	20P1	9/6	DL96	7/3	EZ81	6/-	U26	8/6
1D6	9/9	6K8GT	8/3	20P3	12/6	EA50	1/3	FW4/500	7/-	U31	7/-
1H5GT	8/9	6K25	8/6	20P4	17/-	EABC80	6/6	GT1C	12/6	U33	14/-
1L4	3/-	6L1	9/6	20P5	15/-	EAC91	4/-	GZ32	7/6	U35	12/6
1LD5	4/3	6L6	7/6	25A6G	8/-	EAF42	8/3	GZ34	11/6	U37	26/-
1LN5	4/6	6L6G	6/6	25L6GT	7/9	EB34	1/3	HK90	9/6	U50	4/9
1N5GT	8/9	6L18	7/9	25Y5G	8/-	EB41	5/-	HL41DD	8/6	U52	4/9
1R5	5/6	6L19	12/6	25Z4G	7/-	EB91	3/3	HN309	19/-	U76	5/6
1U5	5/3	6LD20	7/9	25Z5	8/-	EBC33	4/9	HVR2	9/-	U78	4/6
1S4	7/6	6N7	7/6	25Z6G	8/-	EBC41	7/9	KT32	6/9	U107	12/6
1S5	4/6	6P1	9/6	27SU	17/6	EBC81	7/9	KT33C	4/-	U191	11/6
1T4	3/-	6P25	8/6	30C1	6/9	EBF80	7/6	KT36	14/-	U281	9/6
2D21	5/6	6P28	9/9	30C15	11/6	EBF83	9/6	KT44	6/-	U282	15/-
3A4	4/-	6Q7G	5/6	30F5	6/-	EBF89	7/9	KT45	8/6	U301	12/6
3A5	8/9	6Q7GT	8/-	30FL1	9/6	EBL21	9/9	KT61	8/6	U309	6/6
3D6	4/-	6R7G	9/-	30L1	6/6	EBL31	17/6	KT63	4/6	U329	9/6
3Q4	7/-	6SA7	5/9	30L15	8/9	EC52	4/9	KT66	13/6	U339	11/6
3S4	5/-	6SC7	4/9	30P4	9/6	EC91	4/6	KT76	8/6	U404	6/-
3V4	6/6	6SG7	4/9	30P12	7/6	EC92	8/6	KTW61	5/9	U801	19/-
5R4GY	9/6	6SH7	3/-	30P19	13/6	ECC31	7/6	KTW62	6/6	UABC80	7/-
5T4	8/-	6SJ7	5/-	30PL1	9/3	ECC32	4/-	KTW63	5/9	UAF42	7/9
5U4G	4/9	6SK7	5/-	30PL13	9/6	ECC33	4/6	KTZ63	11/-	UB41	7/-
5V4G	7/6	6SL7GT	5/9	35C5	8/6	ECC34	9/-	L63	3/-	UBC41	7/6
5Y3G	4/9	6SN7GT	4/6	35L6GT	8/-	ECC35	5/9	LN152	6/6	UBC81	7/9
5Y3GT	5/6	6SQ7	5/9	35W4	6/-	ECC40	9/6	MU14	7/-	UBF80	7/9
5Y4G	9/6	6SS7	3/6	35Z4GT	5/6	ECC81	4/9	N37	10/6	UBF89	7/6
5Z4	9/-	6U4GT	9/6	35Z5GT	7/-	ECC82	4/9	N78	13/-	UBL21	12/-
5Z4G	7/-	6V6G	4/6	41	6/6	ECC83	6/-	N108	13/-	UC92	8/6
5Z4GT	9/6	6V6GT	6/-	42	6/6	ECC84	7/6	N152	8/3	UCC84	12/-
6/30L2	9/-	6X4	4/6	50B5	7/9	ECC85	7/6	P41	3/6	UCC85	7/3
6A6	3/9	6X5G	5/-	50C5	8/6	ECC88	11/6	P61	2/9	UCF80	13/6
6A7	9/-	6X5GT	5/6	50L6GT	7/6	ECF80	8/3	PABC80	8/-	UCH21	9/3
6A8G	7/9	6Y6G	7/6	53KU	9/6	ECF82	8/3	PC86	11/6	UCH42	7/3
6A8GT	12/6	7B6	9/-	61BT	17/6	ECH21	11/6	PC97	9/6	UCH81	7/9
6AC7	3/-	7B7	7/9	61SPT	11/-	ECH35	7/6	PCC84	6/6	UCL82	9/3
6AG5	2/9	7C5	7/3	62BT	13/6	ECH42	8/6	PCC85	7/9	UCL83	12/-
6AG7	6/9	7C6	7/6	75	5/6	ECH81	7/-	PCC88	11/9	UF41	7/6
6AK5	5/-	7H7	7/3	78	5/-	ECH83	8/6	PCC89	8/6	UF42	5/6
6AL5	3/3	7S7	8/9	80	5/6	ECL80	6/6	PCC189	13/6	UF80	7/-
6AM6	3/-	7Y4	5/-	83	9/6	ECL82	8/-	PCF80	6/9	UF85	7/6
6AQ5	6/-	7Z4	5/-	185BT	19/6	ECL83	10/6	PCF82	7/-	UF86	14/6
6AT6	5/-	8D3	3/-	185BTA	19/6	ECL86	10/3	PCF84	12/-	UF89	7/-
6AU6	7/-	10C1	11/6	807(A)	5/-	EF22	7/-	PCF86	11/-	UL41	7/-
6AV6	5/9	10C2	14/6	807E	4/9	EF36	3/3	PCL82	7/3	UL44	14/-
6B7	8/6	10F1	4/9	813	49/-	EF37A	7/-	PCL83	9/-	UL46	9/9
6B8G	3/-	10F9	10/6	832	14/-	EF39	4/6	PCL84	7/3	UL84	7/-
6BA6	5/6	10F18	10/-	866A	12/6	EF40	11/-	PCL85	10/-	UM80	9/6
6BE6	5/6	10LD11	14/6	954	3/9	EF41	8/-	PCL86	10/6	UR1C	7/6
6BG6G	15/-	10P13	8/6	955	2/3	EF42	6/9	PEN25	3/9	UU6	12/-
6BH6	6/-	10P14	9/6	956	2/-	EF50-BR	1/6	PEN45	8/6	UU7	9/6
6BJ6	5/9	10P18	7/-	1625	5/6	EF50(A)	2/6	PEN46	4/6	UU8	13/6
6BR7	8/6	12A6	2/3	5763	7/6	EF54	3/3	PL33	9/6	UY1N	11/-
6BR8	9/6	12AH8	9/-	9001	3/6	EF80	4/6	PL36	9/6	UY21	9/6
6BW6	6/9	12AT6	6/6	9002	4/9	EF85	6/-	PL38	17/6	UY41	6/-
6BW7	5/-	12AT7	5/6	9003	5/9	EF86	7/6	PL81	8/3	UY85	6/-
6C4	2/3	12AU6	9/-	ATP4	2/6	EF89	6/9	PL82	6/6	VP4B	9/-
6C5	5/6	12AU7	6/-	AZ31	7/6	EF91	3/-	PL83	6/6	VP23	2/9
6C6	3/6	12AV6	6/9	AZ41	7/-	EF92	3/-	PL84	7/6	VP41	5/6
6C9	11/-	12AX7	6/6	B36	6/9	EF183	9/9	PL820	8/3	VR105	5/6
6CD6G	17/6	12BA6	7/-	C1C	8/-	EF184	9/6	PM84	9/6	VR150	5/-
6CH6	6/6	12BE6	6/6	CCH35	13/6	EK32	7/6	PX4	12/6	W76	4/9
6D2	3/3	12BH7	8/9	CL33	9/-	EL32	3/9	PX25	9/-	W81	7/3
6D3	9/6	12C8	5/6	CY31	7/6	EL33	7/-	PY31	8/-	X65	11/-
6D6	3/-	12E1	17/6	D77	3/3	EL34	11/6	PY32	10/-	X66	7/9
6F1	4/9	12H6	1/9	DA30	11/6	EL35	6/-	PY33	11/-	X76M	11/-
6F6	7/6	12J5GT	3/3	DAC32	9/9	EL38	12/6	PY80	6/6	X78	21/-
6F6G	4/6	12J7GT	8/-	DAF91	4/6	EL41	8/-	PY81	6/3	X79	21/-
6F13	4/9	12K7GT	4/6	DAF96	7/3	EL42	7/9	PY82	5/9	Z63	4/9
6F14	9/6	12K8	9/9	DF33	8/9	EL81	8/9	PY83	6/9	Z66	8/6
6F15	9/6	12K8GT	9/6	DF91	3/-	EL84	6/6	PY88	9/-		
6F19	6/-	12Q7GT	4/6	DF96	7/3	EL85	9/9	PY800	9/-		
6F32	4/9	12SA7	7/-	DF97	7/6	EL91	3/9	PZ30	9/6	*Transistors:*	
6F33	4/-	12SG7	4/6	DH63	5/6	EL95	6/6	R19	9/6	AF117	7/-
6H6	1/6	12SH7	3/6	DH76	4/6	EM34	8/6	RL18	11/-	OC26	12/6
6J5	4/3	12SJ7	5/6	DK32	9/6	EM80	7/9	SP41	2/3	OC36	14/-
6J5G	3/-	12SK7	4/6	DK91	5/6	EM81	8/6	SP61	2/-	OC44	5/6
6J5GT	4/3	12SN7GT	6/9	DK92	7/-	EM84	8/9	SU25	16/-	OC45	6/-
6J6	3/6	12SQ7	8/6	DK96	7/3	EM85	9/6	SU2150	4/6	OC72	5/6
6J7	8/6	13D3	5/6	DL33	7/6	EN31	16/-	T41	6/9	OC81	5/6
6J7G	4/9	14S7	14/6	DL35	7/6	EY51	7/6	TDD4	8/6	OC81D	5/6
6J7GT	7/6	19AQ5	7/9	DL63	9/-	EY86	7/3	U14	7/6	OC170	8/9
6K6GT	6/-	19BG6	14/-	DL75	6/-	EY88	9/6	U18	7/6	XB104	5/6

Post: 2 lbs. 2/-, 4 lbs. 2/6, 7 lb. 3/6, 15 lbs. 4/-, etc. (C.O.D. 2/- extra) ALL ITEMS LESS 5% AND POST FREE IN DOZENS.

Send 6d. for list of 1,000 snips.

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MAIL ORDER ONLY **DEVONIAN COURT, PARK CRESCENT PLACE, BRIGHTON 7, SUSSEX.**

Stern's

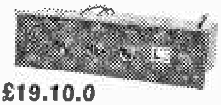
SPECIALISTS IN SOUND EQUIPMENT FOR OVER 25 YEARS

STEREO TAPE PRE-AMPLIFIER

MODEL STP-1. For use with current TRUVOX, BRENELL, or COLLARO "STUDIO" ½ and ¼ track Stereo Decks. Incorporates Ferroxcube Oscillator, 4 speed Equalisation Signal Level Meter and separate Gain Controls. Includes separate Power Unit.

KIT OF PARTS **£22.0.0** ASSEMBLED **£28.0.0**

TAPE PRE-AMPLIFIER MULLARD'S Type "C"



Suitable for most ¼ track, Mono Tape Decks. Incorporates Ferroxcube Push-Pull Oscillator and 3 Speed Treble Inductor. Includes Separate Power Unit.

KIT OF PARTS **£14.0.0** ASSEMBLED **£19.10.0**

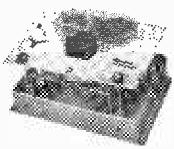
MULLARD'S TAPE AMPLIFIER

MODEL HF/TR3

Based on Mullard's Type "A" design and suitable for most ¼ track Mono Tape Decks. Incorporates Ferroxcube 3 speed Treble Inductor and Gilsen Output Transformer. Includes separate Power Unit.

KIT OF PARTS **£13.13.0** ASSEMBLED **£19.0.0**

STERN'S "ADD-A-DECK"



A self contained Unit consisting of Garrard Deck and matched Preamplifier on one chassis. Provides full tape recording facilities and replays through Pick-up Sockets or standard Radio receiver or Amplifier.

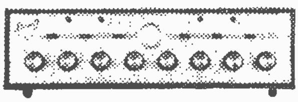
PRICE includes Spool of Tape **£18.18.0**

and *NOW!!! STERN'S* OFFER THE "VICEROY" and "EMPRESS" STEREOSCOPE UNITS

A SPECIAL BULK PURCHASE ENABLES US TO OFFER THIS HIGH GRADE STEREOPHONIC PRE-AMPLIFIER AT APPROX. THE MANUFACTURER'S PRODUCTION COST. IT IS ENGINEERED TO THE VERY HIGHEST TECHNICAL STANDARDS AND REPRESENTS THE ULTIMATE IN PRECISION HIGH FIDELITY EQUIPMENT FOR DOMESTIC INSTALLATIONS.

EXCEPTIONAL VALUE

10 + 10 WATTS



AUDIO PERFECTION - REMARKABLE FLEXIBILITY THE "EMPRESS"

Unquestionably the most advanced self-powered STEREOPHONIC Pre-amplifier available today, it provides the greatest range of facilities ever offered in a single unit. It incorporates full input facilities for Crystal or Magnetic Pick-ups and Microphones, Radio Transmissions, Tape Recorders and Replay direct from high impedance Tape Heads. A miniature Cathode Ray Tube provides for VISUAL balancing of the input signals, and also for measuring the frequency response of PICK-UPS and the power output in watts. The controls include Scratch and Rumble Filters, Loudspeaker phasing in conjunction with a 50 cycles per second note, Channel reversal and Mixing facilities together with Function Switches, separate Volume and Baxandall Tone Controls. Size 14in. x 10½in. x 4in.

OFFERED AT THE SPECIAL PRICE OF LIST PRICE £40.19.0. **£17.17.0**

The Empress is designed to operate with any good quality Stereophonic Power Amplifier requiring an input between 100m/Volts and 3 Volts and is particularly suitable to operate with our MULLARD "10+10" POWER AMPLIFIER—WE OFFER IT together with the "10+10" for only........ **£36.0.0**

!! COMBINED PRICE OFFERS !!

Includes small charge for special testing and PRECISE MATCHING of the ASSEMBLED PRE-AMPLIFIER (or Amplifier) to TAPE DECK

STP-1 (Kit) and "STUDIO" Deck	£39.0.0	Assembled £46.0.0
STP-1 (Kit) and Brenell Deck	£66.0.0	Assembled £75.0.0
STP-1 (Kit) and Truvox Deck	£51.0.0	Assembled £59.0.0
TYPE "C" (Kit) and "STUDIO" Deck	£26.10.0	Assembled £33.0.0
TYPE "C" (Kit) and BRENELL Deck	£43.0.0	Assembled £50.0.0
TYPE "C" Assembled and Wearite Deck	£70.0.0	Inc. Head Lift Trans.
HF/TR3 (Kit) and "STUDIO" Deck	£26.0.0	Assembled £33.0.0
HF/TR3 (Kit) and BRENELL Deck	£43.0.0	Assembled £50.0.0
HF/TR3 Assembled and Wearite Deck	£70.0.0	Inc. Head Lift Trans

To build a complete TAPE RECORDER we offer HF/TR3 AMPLIFIER STUDIO DECK, PORTABLE CASE, ROLA 10 x 8in. SPEAKER MICROPHONE and 1,200ft. TAPE ALL for £35.0.0. ALTERNATIVELY WE OFFER.... THE COMPLETELY ASSEMBLED and GUARANTEED PORTABLE RECORDER ....(Model CR3/S)....FOR....£43.0.0.

Stereo Amplifiers

MULLARD'S "10+10" STEREO AMPLIFIER

A high fidelity design providing up to 10 watts (per channel). Superb reproduction frequency response flat to within 3db from 3 c/s to 60 Kc/s at 50mW Total Harmonic Distortion at 10 watts 0.1%.

Price (a) ASSEMBLED AMPLIFIER (as illustrated) **£24.0.0**

(b) KIT of PARTS............ **£20.0.0**

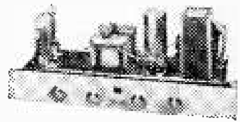
Built to the highest technical standards and presented strictly to MULLARD'S specification. Two specially designed GILSON OUTPUT TRANSFORMERS with 20% taps are used.

We can also supply the assembled MAIN AMPLIFIER only for operation with our DUAL CHANNEL PRE-AMPLIFIER: this provides a more versatile Installation and is essential if a low output Magnetic Pick-up is to be used. When ordering specify loudspeaker impedance.

(a) THE ASSEMBLED MAIN AMPLIFIER and ASSEMBLED DUAL CHANNEL PRE-AMP..................... **£34.0.0**

(b) KIT OF PARTS for both Units....................... **£27.0.0**

THE "TWIN THREE" STEREO AMPLIFIER

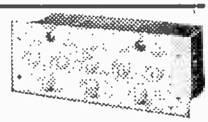


ASSEMBLED AND TESTED

£9.0.0 (Carriage and Insurance 7/6 extra)

Based on a recent design by MULLARD LTD., is ideally suited for use in Portable RECORD PLAYERS for which purpose we offer a specially designed Case: incorporates MULLARD ECL86 Valves, separate BASS and TREBLE CONTROLS and produces up to 3 watts per channel. Frequency response is 40 c/s to 30 Kc/s, size is only 11½in. x 3in. x 5in. To construct a STEREO PORTABLE RECORD PLAYER we offer: Assembled AMPLIFIER with two ROLA 8in. x 5in. LOUDSPEAKERS and PORTABLE CASE for.................. **£16.10.0**

MULLARD DUAL-CHANNEL PRE-AMPLIFIER



A four Valve design for both STEREOPHONIC and MONOPHONIC operation. Operates equally well with any make of Amplifier requiring an input of up to 250 m/v.

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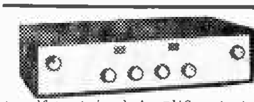

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Tape Amplifier for B.S.R. deck, printed circuit ready wired, with ECC83, ECL82, EM85 and EZ81. Complete with all plugs, sockets, panels, knobs, etc. The whole amplifier mounts on to the deck, making a self-contained unit — £8.8.0
Deposit £1.0.0 and 8 monthly £1.1.0

Case with 7in. x 4in. speaker, in two tone grey — £4.4.0

Complete Kit as above — £22.0.0
Deposit £2.4.0 and 12 monthly £1.16.6

The above recorder can be supplied assembled, tested and complete with tape and microphone for — £25.0.0
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Collaro Studio Deck. Very latest model 3 speeds 7in. spools — £12.10.0
Deposit £1.5.0 and 12 monthly £1.0.8

Tape Amplifier for studio deck, with ready wired printed circuit control and input panels, mains and output transformers. Complete with valves, knobs, plans, screws, etc. EF86, ECC83, EM84, EZ81, OA81 and 2 EL84. 3 watts output. Magic eye, radio and mic. inputs, EX L/8 socket, tone and monitor controls. Can be used as an amplifier — £11.11.0
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Case for above including 9in. x 5in. speaker — £5.5.0

Total Kit as above — £29.0.0
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We can offer the above recorder, complete with tape and microphone, in a De Luxe two tone grey cabinet, assembled for — £35.0.0
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This Machine is listed at 39 gns. by makers and is a very good buy.
Building Instructions available at 2/6 each kit (refunded if kit bought)

QUARTER TRACK

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Tape Amplifier as above, but quarter track — £9.9.0
Deposit £1.0.0 and 9 monthly £1.1.0

Case, two tone grey, with speaker — £4.4.0

Complete Kit as above — £25.0.0
Deposit £2.10.0 and 12 monthly £2.1.6

Collaro Studio Deck, 4 track — £17.17.0
Deposit £1.17.6 and 12 monthly £1.9.5

Tape Amplifier, as above, but 4 track — £12.12.0
Deposit £1.7.0 and 12 monthly £1.0.8

Case with 9in. x 5in. speaker — £5.5.0

Complete Kit 4 track Collaro — £35.0.0
Deposit £3.10.0 and 12 monthy £2.10.2

Tape Pre-amplifier for Collaro deck, with power supplies, ECC83, ECL82, EZ80 and EM85, Radio and Mic. sockets, gives an equalised output of 400 m/Volts
Half Track — £8.8.0
Deposit £1.0.0 and 8 monthly £1.1.0
Quarter Track — £9.9.0
Deposit £1.0.0 and 9 monthly £1.1.0

Marriott Tape Heads. 4 track type L/RPS/7 and L/ES/9 Record/Playback and Erase with mounting bracket for Studio deck
Pair Complete (Marriott list price is £8.14.0) — £4.4.0

Bradmatic R/PB and Erase on Collaro bracket ¼ track — £1.19.6

Bradmatic R/PB. Ideal 3rd head Collaro deck ¼ track — £1.12.6
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The instruction books are included in all kits but are otherwise 2/6.

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Mercury 2 as JTV/2 but less power, with all valves — £10.15.0
Deposit £1.1.6 and 12 monthly 17/10

The instruction book is again included but is otherwise 3/6.
All the above units are available ready built and aligned. Price on request.

RADIO TUNERS

Armstrong T4 C. V.H.F. Tuner self powered — £17.19.0
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Armstrong ST3 Mk2. AM/FM self powered — £25.12.0
Deposit £2.13.0 and 12 monthly £2.2.4

Armstrong AF208 AM/FM Radio chassis, Bass and Treble controls, P.U. inputs etc. — £21.4.0
Deposit £2.6.0 and 12 monthly £1.14.10

Armstrong Jubilee Mk2. AM/FM Push-pull output stage. Bass and Treble — £28.5.0
Deposit £2.16.6 and 12 monthly £2.6.11

Armstrong Stereo 55, AM/FM Radio chassis, with stereo gram. Bass and Treble etc. — £29.18.0
Deposit £3.2.6 and 12 monthly £2.9.5

Armstrong Stereo 12 Mk2. AM/FM Radio chassis, Stereo gram. Push-pull output — £40.5.0
Deposit £4.0.6 and 12 monthly £3.6.11

Brass escutcheon available for AF208 and Jub. Mk2 — 7/6

Pye HFT109, FM tuner self powered — £23.12.6
Deposit £2.9.6 and 12 monthly £1.19.0

Pye HFT113, AM/FM Tuner self powered — £28.7.0
Deposit £2.18.6 and 12 monthly £2.6.11

Quad F.M. Tuner un-powered — £24.18.9
Deposit £2.13.3 and 12 monthly £2.1.1

AMPLIFIERS (MONO)

Linear L45 Three valve amplifier — £5.19.6

Linear Diatonic Five valve, push pull — £12.12.0
Deposit £1.7.0 and 12 monthly £1.0.8

Linear Concord 30 watt with case — £18.0.0
Deposit £1.16.0 and 12 monthly £1.9.10

Tripletone Hi Fi Major, with Pre-amp — £15.18.9
Deposit £1.15.3 and 12 monthly £1.6.1

Pye Mozart, including Pre-amp, 10 watt — £25.4.0
Deposit £2.10.6 and 12 monthly £2.1.11

Leak TL 12. Main amp. only 10 watt — £18.18.0
Deposit £2.0.6 and 12 monthly £1.11.1

Leak Varislope 111 Pre-amplifier — £15.15.0
Deposit £1.11.6 and 12 monthly £1.6.1

Quad Main amp. only 15 watt — £22.10.0
Deposit £2.5.0 and 12 monthly £1.17.4

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Dulci GA505, Integrated — £18.18.0
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Rogers Cadet Mk2, with Pre-amplifier — £25.10.0
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Leak Stereo 20 Main amplifier — £30.9.0
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Quad 22 Stereo Control unit, Pre-amplifier — £25.0.0
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Garrard Autoslim De Luxe Mono cartridge — £11.9.0
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Philips AG1016 with Stereo cartridge — £12.12.0
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Decca Deram Transcription cartridge — £4.14.6

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Goldring GL58, with arm, less cartridge — £15.19.8
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3S4 6/-	6J7GT 10/6	12AU7 5/-	83V 19/5	DF97 9/-	ECL82 9/6	GZ34 14/-	PEN4DD	UCH81 9/6	W42 22/8	OC28 17/6
3V4 7/6	6J8 12/6	12AV6 11/1	85A1 55/6	DH30 15/6	ECL83 18/9	GZ37 19/5	25/11	UCL82 9/6	W61M 27/3	OC29 27/6
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5Y4 12/6	6L1 22/8	12J5GT 4/-	150B2 16/6	DK32 12/-	EF39 4/6	HL23 14/11	PEN46 4/6	UF89 8/-	W729 19/5	OC45 9/-
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6A8 9/-	6L18 13/-	12Q7GT 5/-	220B 10/6	DL33 9/6	Brit. 5/-	HN309 29/1	PENB4	UM4 17/9	X61 12/6	OC71 6/6
6AB7 8/-	6L19 22/8	12SA7 8/6	301 20/-	DL35 12/6	Amer. 7/-	HVR2A 6/-	23/11	UM34 16/10	X63 9/-	OC72 8/-
6AC7 4/-	6LD3 8/-	12SC7 8/6	304 15/-	DL63 10/-	EF54 5/-	HVR2 10/-	PENDD	UM80 14/11	X64 7/6	OC73 16/-
6AG5 5/6	6LD13 11/8	12SG7 7/-	305 13/-	DL66 17/6	EF73 10/6	1W3 10/-	4020 34/-	UR1C 18/2	X65 12/6	OC74 8/-
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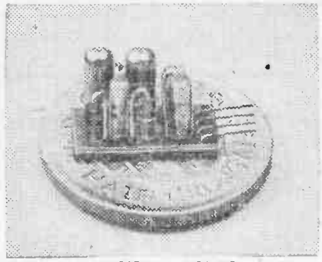

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5) Simple to build with ordinary tools.
6) Uses **Micro-Alloy transistors** throughout.
7) Free applications data gives circuits for using micro-amp. in **micro-radios, transmitters,** etc.

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● STEREO COMPONENTS

Morganite ganged potentiometers as specified for the Mullard circuits. ★ Log/Anti-Log. 500k, 1 meg., 2 meg. ★ Log/Log. 50k, 250k, 1 meg., 2 meg. ★ Lin/Lin 250k, 500k, 1 meg. All 10/6 each.

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AVO Multiminor Mark 4	£9.10.0	£1.19.0	12 of	14/4
T.M.K. TP10	£3.19.6	£1. 3.6	3 of	£1. 2.0
T.M.K. TPS5	£5.19.6	£1.15.6	3 of	£1.11.4
T.M.K. Model 500	£8.19.6	£1.15.6	12 of	13/8
TAYLOR MODEL 127A	£10.10.0	£2. 2.0	12 of	15/8
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GARRARD AUTOSLIM De-luxe AT6 (Mono PU)	£11. 9.0	£2. 6.0	12 of	16/11
GARRARD AUTOSLIM De-luxe AT6 (S/M PU)	£12. 5.4	£2. 9.4	12 of	18/-
B.S.R. UA14 (TC8 Mono PU)	£6.19.6	£1. 7.6	12 of	11/-
B.S.R. UA14 Monarch (TC8S Stereo/LP/78)	£7.19.6	£1.11.6	12 of	12/4
B.S.R. UA16 (TC8 Mono PU)	£7.19.6	£1.11.6	12 of	12/4
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WHITELEY: HF106 10in., £7.0.0.; HF1012 10in., £4.7.6; HF816 8in., £6.0.0; T816 8in., £5.13.6; T10 Tweeter, £4.8.3; T359 Tweeter, £1.10.6; CX3000 Crossover unit, £1.11.6; CX1500 Crossover unit, £2.0.0. H.P. Terms available on all speakers.

★ TERMS OF BUSINESS
Cash with order or C.O.D. We charge C.O.D. orders as follows: Up to £3, minimum of 3/2. Over £3 and under £5, 1/6. Over £5 and under £10, 1/8. Over £10, no charge. **Postage extra on CASH orders under £3 except where stated. Postage extra on overseas orders irrespective of price.**

WATTS RADIO

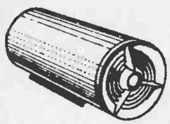
(MAIL ORDER) LTD.
54 CHURCH ST., WEYBRIDGE, SURREY
Telephone: Weybridge 47556
Please note: Postal business only from this address
Callers welcome by appointment

★ HIRE PURCHASE TERMS
are available on any item. Repayments may be spread over 3, 6 or 12 months. Details as follows: Three months; Deposit 6/- in the £. Service charge 5 per cent, but minimum charge of 10/-. Six and Twelve months: Deposit 4/- in the £. Service charge 10 per cent, but minimum charge 20/-.

POST FREE MAIL ORDER SERVICE

All goods sent by return

TRANSISTOR RADIO ESSENTIALS



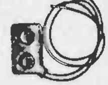
T.S.30 Booster Speaker. Plugs into earpiece socket of most miniature radios and tape recorders. Double the volume and a Hi-Fi Stereo effect that will amaze you. 9½ x 3½in.

PRICE 29/-

LA.6P A.C. Adaptor. Enables 9 v. battery sets to be run off A.C. mains, also re-activates old 9 v. batteries.

PRICE 24/6

MINIATURE COMPONENTS



BH.9 9 v. Battery Connector for P.P.3, T.6003, etc. 1/- each. SP.31 Standard Shielded chrome barrel plug, screw terminals, 3/- each. P.31 Standard black bakelite barrel plug, 2/6 each. T.104 Toggle Switch S.P.S.T. with on/off plate, 2/- each. MR.60 Magnetic earphone, 250 ohm with earcurl, lead and plug, 6/- each.

S.A.E. for Miniature Component Leaflet

HI-FI AMPLIFIERS

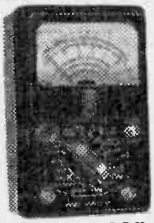
SA.80 Integrated Stereo Amplifier. 4 x 4 watt. The perfect choice for a low cost, Hi-Fi stereo system. Dual pick-up and tuner inputs. Supplied complete for only £9.10.0.

SA.300 Integrated Stereo Amplifier. 15 x 15 watt. Incorporates all the latest refinements to give you professional quality Hi-Fi reproduction. Modestly priced at £32.10.0. S.A.E. for leaflets.

Full range of Eagle Products always in stock

All goods available as previously advertised

MULTI-METERS



Model EP.100K. 100,000 O.P.V. A handy size high sensitivity multi tester, with shockproof 9.5μA meter. Ranges D.C. volts, A.C. volts, D.C. amps, Ohms, etc. Size 5¾ x 3¾ x 2⅛in. Originally £14.14.0.

RELDA EXCLUSIVE OFFER

UNOBTAINABLE ELSEWHERE **£6.19.6**

EP. 10K. 10,000 O.P.V. in Kit form £3.9.6.
TK. 20A. 1,000 O.P.V. complete £2.9.6.

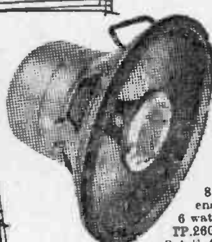
Leaflets available.

R.F. FIELD INDICATOR

FL.30H. Designed for checking the radiation from a transmitting antenna. The sensitivity can be controlled by adjustment of panel control the antenna length or by increasing distance from the radiator. Freq. range 1-200 Mc/s. 200μA D.C. Meter. Complete as illus. with instructions. Price 69/6.

VISIT OUR HI-FI SHOWROOM AT 87, TOTTENHAM CT. RD., W.I

HI-FI SPEAKERS



CX. 300. 12in. Two Way (illus.). Crisp clean frequency response from 30-16,000 cps. 15 watt. 16 ohms. Price 12 gns.
CR.12AE. 12in. Two Way. True Hi-Fi and superb stereo at low cost. Response 30-16,000 cps. 10 watt. 16 ohms. Price 8 gns.
CR.30AE. 12in. Three Way. Advanced triaxial design giving full 3 speaker performance. Response 30-16,000 cps. 10 watts. 16 ohms. Price 10 gns.
S.A7. 8in. Two Way. Dual cone construction ensures wide range response. 50-16,000 cps. 6 watt. 16 ohms. Price 81/-.
TP.26G. 2⅝in. 75 ohm speaker. Price 11/-.
S.A.E. for leaflets.

MICROPHONES

M.C.70 (illus.) CRYSTAL. 360 deg. pick up. Response 50-12,000 cps. Price 59/6.
100.C 3 way SLIM CRYSTAL. Response 60-10,000 cps. Price 48/-.
DM.11 DYNAMIC with base. Response 60-12,000 cps. Price £5.5.0.
DM.175 LIGHTWEIGHT DYNAMIC. Response 150-9,000 cps. Price 39/6.
BM.36R MAGNETIC LAPEL TYPE. 1¼in. dia. Price 12/6.
S.A.E. for leaflets.

5-STAGE TRANSISTOR RADIO

Completely portable, has the appearance of sets costing considerably more and works equally well. Incorporates telescopic aerial and ferrite rod to really pull in those stations, genuine 2⅝in. speaker also earpiece with ear curl for personal listening. G.E.C. transistors, tuning control, volume control with switch etc. Attractive case size 5¼ x 3½ x 1⅞in. Can be built in one hour. ALL PARTS SOLD SEPARATELY PRICE 47/6.

Relda Radio Ltd.

MAIL ORDERS TO: DEPT. 'P' 32A, COPTIC STREET, LONDON, W.C.1 Tel: MUSeum 9606

R.S.C. (Manchester) Ltd.

MAIL ORDERS to 5 County Arcade, Leeds 1. Terms: C.W.O. or C.O.D. No C.O.D. under £1. Postage 2/9 extra under £2. 4/6 extra under £5. Trade Supplied. S.A.E. with all enquiries please.

LEICESTER: 32 High St. Half-day Thursday | BIRMINGHAM: 6 Gt. Western Arcade (Opp Snow Hill Sta.) No half-day | SHEFFIELD: 13 Exchange St. Castle Market Bldgs. Sheffield | HULL: 51 Savile St., Hull Half-day Thursday | LIVERPOOL: 73 Dale St. Liverpool 2 | BRADFORD: 56 Morley St. (above Alhambra Theatre) Bradford Half-day Wednesday | MANCHESTER: 8-10 Brown St. (Market St.) Manchester 2 No half-day | LEEDS: 5-7 County (Mecca) Arcade Briggate, Leeds Half-day Wed.

SENSATIONAL STEREO OFFER

(4 Gns.) A complete set of parts to construct a good quality Stereo amplifier with an undistorted output total 6 watts. For A.C. mains input of 200-250 v. Including pair matched 6½in. speakers. Sensitivity 130 m.v. Ganged Vol. and Tone Controls. Preset balance control. Full instructions and wiring diagrams supplied. Stereo Pick-up Head 19/9 extra with above only.

R.S.C. 30-WATT ULTRA LINEAR HIGH FIDELITY AMPLIFIER A10

A highly sensitive Push-Pull high output unit with self-contained Pre-amp. Tone Control Stages. Certified performance figures compare equally with most expensive amplifiers available. Hum level 70 db down. Frequency response ±3 db. 30-30,000 c/s. A specially designed sectionally wound ultra linear output transformer is used with 807 output valves. All components are chosen for reliability. Six valves are used EF86, EF86, ECC33, 807, 807, GZ34. Separate Bass and Treble Controls are provided. Minimum input required for full output is only 12 millivolts so that **ANY KIND OF MICROPHONE OR PICK-UP IS SUITABLE.** The unit is designed for **CLUBS, SCHOOLS, THEATRES, DANCE HALLS or OUTDOOR FUNCTIONS,** etc. For use with Electronic **ORGAN, GUITAR, STRING BASS,** etc. For standard or long-playing records. **OUTPUT SOCKET PROVIDES** L.T. and H.T. for a **RADIO FEEDER UNIT.** An extra input with associated vol. control is provided so that two separate inputs such as Gram. and "Mike" can be mixed. Amplifier operates on 200-250 v. 50 c/s. A.C. Mains and has output for 3 and 15 ohm speakers. Complete Kit of parts with fully punched chassis and point-to-point wiring diagrams and instructions. If required perforated cover with carrying handles can be supplied for 19/9. The amplifier can be supplied, factory built with EL34 output valves and 12 months guarantee, for 14 gns.

11 Gns. Carr. 10/-

TERMS: DEPOSIT 33/9 and 9 monthly payments of 33/9.
Suitable microphones and speakers available at competitive prices.

WE STOCK ARMSTRONG, DULCI AND JASON EQUIPMENT GOODMANS AND W.B. SPEAKERS
GARRARD AND GOLDRING T/TABLES

SUPERHET FEEDER UNIT. Design of a high quality Radio Tuner (specially suitable for use with our Amplifiers). Delayed A.V.C. Controls are Tuning, W/Ch. and Vol. Only 250 v. 15 mA. H.T. and L.T. of 6.3 v. 1 amp. required from amplifier. Size approx. 9 x 6 x 7in. high Simple alignment procedure. Point-to-Point wiring diagrams, instructions and priced parts list with illustrations, 2/3. Total building cost £4.15.0. S.A.E. for leaflet.

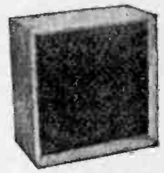
P.M. SPEAKERS. 10in. W.B. "Stentorian" 3 or 15 ohms type HF 1012 10 watts, hi-fidelity type. Recommended for use with our A11 Amplifier, £4.7.6. 12in. R.A. 3 ohms 10 watts (12,000 lines), 59/6.

TWEETERS. Plessey 3Ω 19/9, 15Ω 25/9.

Jason FMT1 V.H.F./F.M. Radio Tuner design. Total cost of parts including valves Tuning dial, Escutcheon, etc., £6.19.9. Other Jason equipment in stock.

LINEAR L45 MINIATURE 4/5 WATT QUALITY AMPLIFIER. Suitable for any record playing unit, and most microphones. Negative feed-back 12 db. Separate Bass and Treble Controls. For mains 200-250 v. 50 c/s. Output for 2-3 ohm speaker. Mullard vales EZ80, ECC83, EL84. Size only 7-5-5½in. high. Guaranteed 12 months. Only £5.19.6. Send S.A.E. for leaflet. Terms: Deposit 22/6 and 5 monthly payments of 22/6

12in. 10 WATT HIGH QUALITY LOUDSPEAKER



in walnut veneered cabinet. Gauss 12,000 lines. Speech coil 3 ohms or 15 ohms. Only £4.19.6 Carr. 5/-. Terms: Deposit 11/3 and 9 monthly payments of 11/3.
12in. 20 WATT HI-FI LOUDSPEAKERS IN CABINETS. Size 18 x 18 x 10in. Finish as above. Terms: Deposit 17/9 and 9 monthly payments of 17/9. Only £7.19.6. Carr. 8/6.

BASS GUITAR LOUDSPEAKER IN CABINET. 15in. 50 watt. highly sensitive unit in Rexine covered acoustically lined cabinet. Deposit £3.7.6 and 12 monthly payments of £2.10.0. **29 Gns.** Carr. 15/-

R.S.C. 4-5 WATT A5 HIGH-GAIN AMPLIFIER

A highly-sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high fidelity pick-up heads, in addition to all other types of pick-ups and practically all "mikes". Separate Bass and Treble Controls are provided. These give full long-playing record equalisation. Hum level is negligible being 71 db. down 15 db. of Negative feedback is used. H.T. of 300 v. 25 mA. and L.T. of 6.3 v. 1.5 a. is available for the supply of a Radio Feeder Unit, or Tape-Deck pre-amplifier. For A.C. mains input of 200-230-250 v. 50 c/s. Output for 2-3 ohm speaker. Chassis is not alive. Kit is complete in every detail and includes full punched chassis (with baseplate) with Blue hammer finish and point-to-point wiring diagrams and instructions. Exceptional value at only £4.15.0, or assembled ready for use 25/- extra. Plus 3/6 carr., or deposit 22/6 and 5 monthly payments of 22/6 for assembled unit.

NOW OPEN AT LEICESTER

AUDIOTRINE HIGH FIDELITY REPRODUCERS

THE DUO/10. Consisting of a 12in. 12,000 line Speaker with heavy four layer voice coil, the Audiotrine cross-over unit, and a 4in. Diameter Tweeter Unit incorporated in the extremely attractive Audiotrine Senior Corner Console Cabinet as described below. Matching impedance 15 ohms. Power handling 10 watts nominal, 14 watts peak. Frequency range 40-18,000 c.p.s. Deposit 27/9 and nine monthly payments of 27/9. **12 Gns.**

THE DUO/20. Incorporating a 12in. High Flux 20 watt Speaker with 2in. Diameter Speech Coil. (Total Flux 160,000 lines), the Audiotrine cross-over unit, and a highly sensitive Tweeter unit, in the Audiotrine Senior Corner Console Cabinet. Matching impedance 15 ohms. Peak Power Output 25 watts. Frequency range 30-18,000 c.p.s. Deposit 33/9 and nine monthly payments 33/9. ONLY **14 Gns.**

R.S.C. JUNIOR HI-FI REPRODUCER. The very latest Goodmans Axiette 8 High Fidelity loudspeaker (retailing at approx. 5 gns.) fitted in a specially designed Bass Reflex cabinet size 12in. x 18in. x 10in. Acoustically lined and ported and finished in polished walnut veneer. Matching impedance 15 ohms. Frequency range 40-15,000 c.p.s. Power handling 6 watts nominal. Ideal for Stereo. Limited number. **8 Gns.** Carr. 4/6

R.S.C. BASS REFLEX CABINETS, JUNIOR MODEL. Specially designed for W.B. HF1012 Speaker, but suitable for any good quality 10in. speaker. Acoustically lined and ported. Polished walnut veneer finish. Size 18 x 12 x 10in. Handsome appearance. Ensure superb reproduction for only £3.19.6.

STANDARD MODEL. As above but for 12in. speakers. Size 20 x 15 x 13in. For vertical or horizontal use. £5.19.6. Suitable legs with brass ferrules, 10/6 per set of 4.

R.S.C. CORNER CONSOLE CABINETS

Polished walnut veneer finish. Pleasing design. **JUNIOR MODEL.** Size 20 x 11 x 8in. for 8 x 5in. or 10 x 6in. speakers. £2.9.9. **STANDARD MODEL.** Size 27 x 18 x 12in. for 8 or 10in. speakers. £4.11.9. **SENIOR MODEL.** Size 30 x 20 x 15in. for 12in. Speaker. Suitable Speaker systems below. Only **7 gns.**

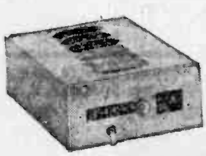
AUDIOTRINE HI-FI SPEAKER SYSTEMS. Consisting of matched 12in. 12,000 line, 15 ohm high quality speaker; cross-over unit (consisting of choke, condenser, etc.) and Tweeter. The smooth response and extended frequency range ensure surprisingly realistic reproduction. Standard 10 watt rating £4.19.9. Carr. 5/-. Or Senior 15 watt. 7 gns. Carr. 7/6.

AUDIOTRINE EQUIPMENT CABINETS

Size 36 x 15 x 18in. Beautiful walnut veneered finish. Elegant contemporary design. Robust construction. Uncut removable baseboard Depth above baseboard 5½. Only 12½ gns. Carr. 15/-.
Terms: Dep. 29/9 and 9 mthly. pymts. 29/9

R.S.C. BATTERY TO MAINS CONVERSION UNITS

Type BM1. An all-dry battery eliminator. Size 5½ x 4½ x 2in. approx. Completely replaces battery supplying 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/s is available. **Suitable for all battery portable receivers requiring 1.4 and 90 v.** This includes low consumption types. Complete kit with diagrams, 39/9, or **ready to use, 46/6.**



Type BM2. Size 8 x 5½ x 2½in. Supplies 120 v. 90 v. and 60 v. 40 mA. and 2 v. 0.4 a. to 1 amp. fully smoothed. **Thereby completely replacing both H.T. batteries and L.T. 2 v. accumulators when connected to A.C. mains supply** 200-250 v. 50 c/s. **SUITABLE FOR ALL BATTERY RECEIVERS** normally using 2 v. accumulators. Complete kit of parts with diagrams and instructions, 49/9, or ready for use, 59/6.

AUDIOTRON HI-FI TAPE RECORDER KIT 25½ GNS. Carr. 17/6

REALISM AT INCREDIBLY LOW COST, CAN BE ASSEMBLED IN AN HOUR

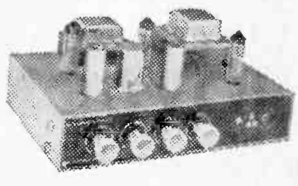
Incorporating the latest Collaro Studio Tape Transcriptor. The audiotrine High Quality Tape Amplifier with negative feedback equalisation for each of 3 speeds. High Flux P.M. Speaker, empty Tape Spool, a Reel of Best Quality Tape and a Handsome Portable carrying Cabinet with latest attractive two-tone polychrome finish, size 14½ x 15 x 8½in. high and circuit. Total cost if purchased individually approximately £40. Performance equal to units in the £60-£80 class. S.A.E. for leaflets. **TERMS.** Deposit £2.13.9 and 12 monthly payments of 44/-. Cash price if settled in 3 months.

ONLY 3 PAIRS OF SOLDERED JOINTS PLUS MAINS

SPECIAL NOTE. The Tape Decks we supply are latest models. Where customers already have a Deck or wish to use one of those being offered cheaply we can supply Kit less Deck at 13 gns. carr. 10/-. Or deposit 2 gns. and 12 monthly payments 23/9. Also if required we can supply in lieu of portable cabinet and 7 x 4in. speaker, the Equipment Cabinet illustrated at foot of opp. page and a high flux 8½ x 5½in. speaker for 8½ gns. extra.

HIGH FIDELITY 12-14 WATT AMPLIFIER TYPE A11

PUSH-PULL ULTRA LINEAR OUTPUT "BUILT-IN" TONE CONTROL PRE-AMP STAGES

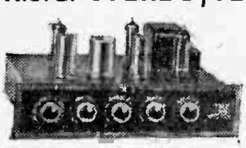


Two input sockets with associated controls allow mixing of "mike" and gram., as in A.10. High sensitivity. Includes 5 valves, ECC83, ECC83, EL84, EL84, EZ81. High Quality sectionally wound output transformer specially designed for Ultra Linear operation and reliable small condensers of current manufacture. INDIVIDUAL CONTROLS FOR BASS AND TREBLE "Lift" and "Cut". Frequency response ± 3 D.B. 30-30,000 c/s. Six negative feedback loops. Hum level 60 D.B. down. ONLY 23 millivolts INPUT required for FULL OUTPUT. Suitable for use with all makes and types of pick-ups and microphones. Comparable with the very best designs. For **STANDARD or LONG PLAYING RECORDS.** For **MUSICAL INSTRUMENTS** such as **STRING, BASS, GUITARS,** etc. **OUTPUT SOCKET** with plug provides 300 v. 30 mA, and 6.3 v. 1.5 a. For supply of a **RADIO FEEDER UNIT.** Size approx. 12-9-7in. For A.C. mains 200-250 v. 50 c.p.s. Output for 3 and 15 ohms speakers. Kit is complete to last nut. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied. Only **8 Gns.** Carr. 10/-
(Or factory built 51/- extra.)
If required louvred metal cover with 2 carrying handles can be supplied for 18/9. **TERMS ON ASSEMBLED UNITS. DEPOSIT** £4/9 and 9 monthly payments of 24/9. Send S.A.E. for illustrated leaflet detailing Ready-to-assemble Cabinets. Speaker, Microphones, etc., with cash and credit terms.

B.S.R. MONARDECK TAPEDECKS. Speed 3¾in. per sec. With high quality recording heads. £6.19.6. Carr. 5/-. Cabinets to take Deck and amplifier 3?/6.

R.S.C. TRANSISTORISED GRAM. AMPLIFIER. Output 1 watt, for 3ohm speaker. Transistors Mullard OC71, OC81D, OC81, OC81. Fitted Vol. Control with switch. Assembled and tested. Suitable for any normal crystal pick-up. Only 59/9.

R.S.C. STEREO/TEN HIGH QUALITY AMPLIFIER



A complete set of parts for the construction of a stereophonic amplifier giving 5 watts high quality output on each channel (total 10 watts). Sensitivity is 50 millivolts, suitable for all crystal stereo heads. Ganged Bass and Treble Control give equal variation of "lift" and "cut". Provision is made for use as straight (monaural) 10-watt amplifier. Valve line-up ECC83, ECC83, EL84, EL84, EZ81. Outputs for 2-3 ohm speakers. Point-to-Point wiring diagrams and instructions supplied. Send S.A.E. for leaflet. **8 Gns.** Full constructional details and price list 2/6. Carr. 10/-.
Kit can be supplied assembled ready to use for 59/6 extra.

HI-FI CRYSTAL PICK-UP HEADS. (Cartridges.) Acos Standard replacement for Garrard, B.S.R. and Collaro. 19/9. Acos Stereo-Monaural 49/9. Ronette Stereo-Monaural 59/6. B.S.R. Stereo 39/9.
BRADMATIC RECORDING HEADS. High Impedance Record/Playback 22/-. Low Impedance Erase, 12/6.
PICK-UP ARMS. Complete and with latest Acos/hi-fi Turnover Cartridge 29/11.
CRYSTAL MICROPHONES. Hand type NP110 14/9, R.T.C. 19/9. Acos Mic 40 25/9, Acos Mic 45 29/6. Stick type Acos 39-1 39/9, BM3 with neck band and heavy table stand 59/9. Lapel type 35/9.
COLLARO JUNIOR 4-speed Single Player Unit and Crystal Pick-up with hi-fi Turnover head. Only £3.19.6.
B.S.R. UA14 4-sp'd AUTO-CHANGERS with hi-fi turnover head, £6.19.6. Carr. 4/6.
GARRARD AUTO-SLIM 4-SPEED AUTO-CHANGER with high fidelity pick-up. Latest model For 200-250 v. A.C. mains, £7.19.6. Carr. 4/6.
GARRARD AT6 AUTO-SLIM DE-LUXE 4-SPEED AUTO-CHANGERS. Turnover GC8 head, for 200-250 v. A.C. mains, 11 gns.
GL3A MINIATURE 2-3 WATT GRAM AMPLIFIER. For use with any single or auto-change unit. Output for 2-3 ohm speaker. For 200-250 v. A.C. mains. Size 11½ x 2½ x 2½in. Controls: Vol. and Tone with switch. Only 59/6.

R.S.C. BATTERY CHARGING EQUIPMENT

All for A.C. Mains 200-250v., 50 c/s. Guaranteed 12 months.

HEAVY DUTY CHARGER KIT 6/12 v. 6 amps. variable output. Consisting of Mains Transformer 0-200-230-250 v.: F.W. (Bridge) Selenium Rectifier: Ammeter, Variable Charge Rate Selector Panels, Plugs. Fuses. Fuseholder and circuit, 59/9. Carr. 4/6.
CHARGER KIT, 12v. 14 AMP or 24v.7amp. Consisting of mains trans. 200-230-250 v. F.W. (Bridge) selenium Rectifier, F Ammeter. Fuses. Variable Resistor and Circuit. Only **6 gns.** Carr. 15/-. Please state if 12v. or 24v. kit required.

SOLDERING IRONS. 230-250 v. 30 watts. First quality. For Radio work. 18/9. Spare elements and bits available.

Assembled 4-5 amps. 6/12 v.
Fitted Ammeter and variable charge rate selector. Also selector plug for 6 v. or 12 v. charging. Louvred steel case with stoved blue hammer finished. Fused and ready for use with mains and output leads. Carr. 5/-. **69/9**
Terms: Deposit 13/3 and 5 monthly payments 13/3.
6/12 v. 3a., all facilities as above. Only 59/9, carr. 3/9.

ASSEMBLED 6/12 v. 2 amps. Fitted Ammeter and selector plug for 6 v. or 12 v. Louvred metal case finished attractive hammer blue. Fused, ready for use with mains and output leads **49/9** Carr. 3/9
6/12 v. 1 amp. 27/9 Less meter.

ASSEMBLED 12V. 1? Amp with variable charge rate adjustment, ammeter and strong louvred, stove enamelled case. Ready for use. Only **7 gns.** Carr. 10/- or in Kit Form 5 gns.

BATTERY CHARGER KITS Consisting of Mains Transformer. F.W. Bridge, Metal Rectifier, well ventilated steel case. Fuses. Fuse-holders. Grommets, panels, Heavy Duty Clips, circuit. Carr. 3/6 extra.
6v. or 12v. 1 amp......... 22/9
As above, with Ammeter 28/9
6 v. ? amps................ 19/9
6v. or 12v. 2 amps......... 25/9
6 v. or 12 v. 2 amps, inclusive of Ammeter......... 35/9
6 v. or 12 v. 4 amps......... 45/9
6 v. or 12 v. 4 amps. with Ammeter and variable charge rate selector............. 52/9

CHARGER AMMETERS
0-1.5 a., 0-3 a., 0-4 a., 0-7 a., 0-25 a., 0-60 a., 8/9.

R.S.C. MAINS TRANSFORMERS (FULLY GUARANTEED)

Interleaved and Impregnated. Primaries 200-230-250 v. 50 c/s. Screened

TOP SHROUDED DROP THROUGH
250-0-250v. 70mA. 6.3v. 2a, 0-5-6.3v. 2a 17/6
350-0-350v. 80mA. 6.3v. 2a, 5v. 2a .. 18/9
250-0-250v. 100mA. 6.3v. 2a. 6.3v. 1a .. 21/9
250-0-250v. 100mA. 6.3v. 3.5a. C.T. .. 19/9
250-0-250v. 100mA. 6.3v. 4a. 0-5-6.3v. 3a 25/9
300-0-300v. 130mA. 6.3v. 4a. 6.3v. 1a, for Mullard 510 Amplifier.. .. .. 29/9
300-0-300v. 100mA. 6.3v. 4a. 0-5-6.3v. 3a 26/9
350-0-350v. 100mA. 6.3v. 4a. 0-5-6.3v. 3a 26/9
350-0-350v. 150mA. 6.3v. 4a. 0-5-6.3v. 3a 29/9
425-0-425v. 200mA. 6.3v. 4a. 5v. 3a .. 40/9

FULLY SHROUDED UPRIGHT
250-0-250v. 60mA. 6.3v. 2a, 0-5-6.3v. 2a, Midget type 2½-3-3in. .. 17/11
250-0-250v. 100mA. 6.3v. 4a. 0-5-6.3v. 3a 27/0
300-0-300v. 100mA. 6.3v. 4 a. 5v. 3a 27/11
300-0-300v. 130mA. 6.3v. 4a. C.T. 6.3v. 1a, for Mullard Amplifier 23/9
350-0-350v. 100mA. 6.3v. 4a. 5v. 3a 27/11
350-0-350v. 150mA. 6.3v. 4a. 5v. 3a .. 35/9

FULLY SHROUDED (continued)—
425-0-425v. 200mA. 6.3v. 4a. C.T. 5v. 3a 55/-
425-0-425v. 200mA. 6.3v. 4a, C.T., 6.3v. 4a, C.T., 5v. 3a. 59/9
450-0-450v. 250mA. 6.3v. 4a. C.T. 5v. 3a 69/9

OUTPUT TRANSFORMERS
Midget Battery Pentode 66 : 1 for 3S4. etc. 4/6
Small Pentode, 5,000Ω to 3Ω 4/6
Small Pentode 7/8,000Ω to 3Ω .. 4/6
Standard Pentode 5,000Ω to 3Ω .. 5/9
Standard Pentode 7,000Ω to 3Ω .. 5/9
10,000Ω to 3Ω 5/9
Push-Pull 8 watts, EL84, or 6V6 to 3Ω or matched to 15Ω 9/9
Push-Pull 10-12 watts to match 6V6 or EL84 to 3-5-8 or 15Ω 19/9
Following types for 3 and 15Ω speakers:
Push-Pull 10-12 watts 6V6 or EL84 .. 18/9
Push-Pull 15-18 watts. 6L6, KT66 .. 22/9
Push-Pull Mullard 510 Ultra Linear . 29/9
Push-Pull 20 watts, sectionally wound. 6L6, KT66. EL34, etc. .. 49/9

MIDGET MAINS Primaries 200-250 v. 50 c/s. 250 v. 60 mA, 6.3 v. 2a. 11/9
250-0-250 v. 60 mA, 6.3 v. 2a .. 12/11
Both above size 2½ x 2½ x 2½ins.

FILAMENT TRANSFORMERS
All with 200-250 v. 50 c/s. primaries 6.3 v. 1.5a. 5/9: 6.3 v. 2a, 7/6: 0-4-6.3 v. 2a, 7/9: 12 v. 1 a. 7/11: 6.3 v. 3 a, 8/11: 6.3 v. 6 a, 17/6: 12 v. 1.5 a. twice, 17/6.

SMOOTHING CHOKES
150 mA, 7-10 H 250 ohms .. 11/9
100 mA, 10 H 200 ohms 8/9
80 mA. 10 H 350 ohms 5/9
60 mA. 10 H 400 ohms 4/11

CHARGER TRANSFORMERS
All with 200-230-250 v. 50 c/s Primaries; 0-9-15 v. 1½ a. 12/9; 0-9-15 v. 2a, 14/9; 0-9-15v. 3 a., 16/9: 0-9-15 v. 5a., 19/9: 0-9-15 v. 6a. 23/9: 0-9-15 v. 8a. 28/9.

AUTO (Step up/Step down) TRANS.
0-110/120-230/250 v. 50-80 watts. 13/9: 250 watts. 39/9: 150 watts. 27/9.

MICROPHONE TRANSFORMERS
120 : 1 high grade, clamped, 6/9: 120 : 1 Plotted. Mu-metal screened. 9/9.

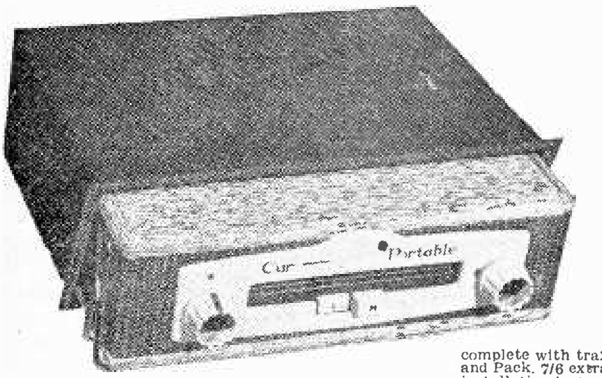
LASKY'S RADIO

CAR PORTABLE Radio SCOOP!!!

Brand new and unused - by famous British Manufacturer. Fully guaranteed. Original list price £26.18.11

A FULLY TRANSISTORISED GO-ANYWHERE PORTABLE THAT AUTOMATICALLY BECOMES A CAR RADIO SIMPLY BY SLIDING INTO A METAL CAR-TRAY.

★ Covers full medium and long wave band. ★ All transistorised superhet. ★ Internal ferrite rod aerial. ★ Press button and wave change. ★ All connections to car battery—booster speaker—car aerial automatically accomplished by sliding into metal car-tray.



Battery drain is exceptionally low—the life of the self-contained battery within the set is approx. 200 hrs. Transistors used: 1 OC44; 2 OC45; 1 OC82D; 2 OC82 and Diode. Compares with set costing at least double, properly installed this set will give you years of pleasure and service both in and out of your car.

Contemporary finish in two tone red and grey vynide. washable material. Supplied complete with car extension loudspeaker, car-tray and full easy-to-follow fixing instructions.

Internal loudspeaker provides ample volume as a portable. Separate 8 x 5in. speaker with 8 x 6in. baffle, for car fixing.

Bracket for padlock provides an effective thief deterrent. Carrying handle folds away when not in use. The scale is illuminated when the set is operating in the car-tray. Dimensions 9¼ x 7¼ x 3in.

As a car radio this receiver operates only from a 12 v. electrical system, either positive or negative earth. As a portable it is powered by its own internal battery type PP9 or equivalent.

LASKY'S PRICE £10.19.6 complete with tray, all car fittings, 8 x 5in. car speaker and baffle. Carr. and Pack. 7/6 extra. PP9 Battery 3/9 extra. Supplied with full fitting and installation instructions.

33 TOTTENHAM COURT ROAD, W.1. 2 mins. Oxford Street. Nearest Station, Goodge Street. MUSeum 2605

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Both addresses open all day Saturday. Close 1 p.m. Thursday.

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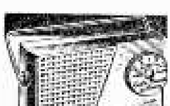
SENSATIONAL NEW 1963 DESIGNS — *BY CONCORD*

LOW PRICES ★★★ PICTORIAL STEP-BY-STEP PLANS ★★★ EASY AS A.B.C.

THE NEW "COSTA BRAVA"



42/6

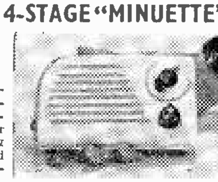
No earth or aerial required. All-transistor Radio. Revolutionary INTERNAL FERRITE AERIAL and moving coil speaker makes it is sensational pocket-size radio the best money-saving bargain of all time. Powerful. superb tone and clarity, ensures perfect reception for all your favourite programmes. Completely portable. only 5¼ x 3 x 1¾in. Two-tone case. Anyone can assemble with our simple PRINTED CIRCUIT PLAN. Send 42/6, plus 2/6 P. & P. (C.O.D. 2/- extra). Satisfaction Guaranteed. (All parts available separately). FREE HIGH SENSITIVITY HIDE-AWAY EAR-PIECE GIVEN WITH EACH SET.

BIG PROFITS FOR YOU IF YOU BUY NOW!

Made to retail at 7 gns. you can now buy this famous Twin-gong Alarm for only 37/6—but only if you act now . . . stocks are strictly limited. Easily installed and operated. Switches on or off at any time. Fantastic FINAL reduction to clear (minimum order of 3). Carr. Free. Free literature sent with each alarm. **37/6**

THE NEW 4-STAGE "MINUETTE"

32/6



Build this newly-designed "MINUETTE" 4-STAGE transistor set in very strong ready drilled ULTRA-MODERN CASE. size only 6 x 3¼ x 1in. Uses three transistors and diode and SELF-CONTAINED LOUDSPEAKER. Very sensitive, ideal for office bedroom, holidays, etc. Months and months of listening on 1/2 battery. Can be built FOR ONLY 32/6, including PROPER CASE, miniature speaker, etc. SIMPLE AS A.B.C. PICTORIAL STEP-BY-STEP PLANS etc., plus post and packing 1/6 (C.O.D. 2/- extra). Parts sold separately, priced parts list 1/-.

FREE HIGH SENSITIVITY HIDE-AWAY EAR-PIECE GIVEN WITH EACH SET

THE MINUTE TRANSISTOR RADIO MIAMI

ONLY 32/6

Unbelievably small—Outrageously cheap. You will be amazed at the fine quality of tone and volume of this great little radio. Only a fantastic 3¼ x 2¾ x 1¼in. the MIAMI will bring you great entertainment for months on a 1/2 battery. Simple assembly plan with each set. ONLY 32/6. YES 32/6! Plus 2/6 P. & P. (C.O.D. 2/- extra). Satisfaction Guaranteed. Demonstrations given daily. Parts available separately if required.

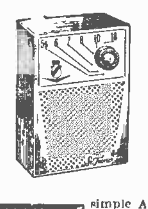
Bulk purchase of bankrupt stock ensures this fabulous money-making offer.

AUTOMATIC CIGARETTE LIGHTER

Instantly provides ready lit cigarette without the driver taking his eyes from the road. Heavily chromium plated case holds 10. Easily and simply fitted to any car's dashboard. Works off 6 or 12 volts. Retail Price 44/9. Special Clearance offer only sold in minimum lots of 6. Carriage free. **12/6** each.

FABULOUS ST. TROPEZ Mk.6

Pocket Radio



ONLY 18/6

NO MORE TO PAY

This fantastic offer will amaze you—the compact ST. TROPEZ measuring 4¼ x 3 x 1¼ receives perfectly in bedroom, office or garden—over all medium waves including Luxembourg. Under ¼d. per hour running cost. ANYONE can assemble it using our simple A.B.C. plan (P.&P.2/6 extra). C.O.D. extra. Parts can be bought separately. Demonstrations daily. Satisfaction guaranteed.

CONCORD ELECTRONICS (Dept. 14/14)
210, Church Road, Hove, Sussex

LASKY'S RADIO

"BUILD YOURSELF" TRANSISTOR RADIOS

GREAT 1963 PRICE REDUCTIONS

New large purchases of components and reductions in purchase tax at the beginning of the year enable you to build your transistor radio at these vastly reduced prices.

The SPRITE

Inclusive price of **79/6** P. & P. 3/6 extra.

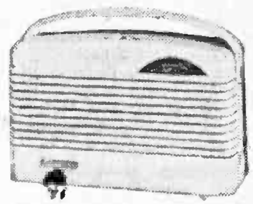
★ Six-Transistor Superhet Miniature Personal Pocket Radio. ★ Tunable over Long and Medium wavebands. ★ Uses PP3 battery. Ferrite Rod aerial. ★ I.F. Frequency 470 Kc/s. Transistors: 3 Philco 2067's 2 Mullard OC81 M, OC81 DM and OA90 diode. ★ 3 inch speaker. ★ Printed circuit 2¼ x 2in. ★ Slow Motion Drive. ★ In Plastic Case, size 4 x 2½ x ⅞in.

In order to ensure perfect results, the SPRITE is supplied to you with R.F. and I.F. stages. Driver and Output stages, ready built with all components ready mounted on the printed circuit. To complete assembly you only have to fit the wavechange switch, tuning condenser and drive, volume control, earphone socket and aerial rod, the remaining components all having been prefitted at the factory for you. The SPRITE is offered as above, pre-assembled, plus cabinet, speaker and all components for final construction, at the inclusive price of 79/6. Postage and packing 3/6 extra. Data and Instruction separately, 2/6. Refunded in parcel is purchased. Real calf leather case, wriststrap, personal earphone and case for earphone and battery 12/6 the lot extra. Make no mistake this is a SUPERHET receiver of genuine commercial quality. It is not a regenerative circuit.

The "REALISTIC" Seven

STAR FEATURES ★★★★

- ★ 7 Transistor Superhet. 350 Milliwatt output into 4-inch high flux speaker.
- ★ All components mounted on a single printed circuit board, size 5¼ x 5½in. in one complete assembly.
- ★ Plastic cabinet, with carrying handle size 7 x 10 x 3½in. in choice of colours:
- ★ Red/Grey, Blue/Grey, all Grey.
- ★ Easy to read Dial.
- ★ External Socket for car aerial.
- ★ I.F. frequency 470 Kc/s.
- ★ Ferrite Rod internal aerial.
- ★ Operates from PP9 or similar battery.
- ★ Full comprehensive data supplied with each Receiver.
- ★ All coils and I.F.'s etc., fully wound ready for immediate assembly.

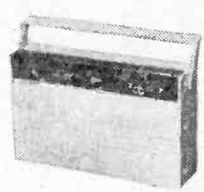


An Outstanding Receiver. Lasky's Price for the complete parcel including Transistors, Cabinet, Speaker, etc., and Full Construction Data: **£5.19.6** Postage and Packing 4/6

PP9 Battery 3/9. Data and instructions separately 2/6, refunded if you purchase the parcel.

The COROVER '6'

★ A 6-transistor plus 2-diode superhet receiver using the latest circuitry. ★ Three Mullard AF117 alloy diffused transistors are used with OA79 and OA91 diodes, followed by OC81D and two OC81's in push-pull. ★ I.F. frequency 470 Kc/s. ★ Covers the full medium and long wavebands. ★ Sockets provided for personal earpiece or tape recorder, and car radio aerial. ★ Large internal ferrite rod aerial gives high sensitivity. ★ Uses four 1.5 v. pen torch batteries. ★ All components mounted on a single printed circuit. Simple stage by stage instructions. ★ Cabinet size 6¼ x 4 x 1½in. With carrying handle. ★ All coils and I.F.'s ready wound. ALL COMPONENTS AVAILABLE SEPARATELY. *Data and instructions separately 2/6. Refunded if you purchase the parcel.*



CAN BE BUILT FOR **£5.7.6**

Post and packing 4/- extra. Batteries 1/4.

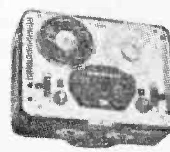
TELEFUNKEN STEREO HI-FI AMPLIFIERS MODEL S82

Further Great Purchase Enables us to Offer this Excellent Unit at £5.19.6. Post 7/6.

A complete stereo amplifier of unsurpassed quality, with inputs for radio, rape recorder, F.M. tuner or any other hi-fi source, either monaural or stereo. Output power 5 watts total (2½ watts each channel). With balance control. New and unused, listed at 16 gns.

LASKY'S PRICE £5.19.6

TESLA "SONET" DUO TAPE RECORDER



A continental manufactured 2-speed tape recorder with 1⅞ x 3¾in. i.p.s. Twin track recording to international standards. ★ Takes 5¾in. spools. ★ Fast forward and fast rewind. ★ Record level indicator. ★ Inputs for mic. radio and pick-up. For use on 110 and 200/250 v. 50 c.p.s. mains. ★ Digital position indicator. ★ In attractive wood case with metal top cover fitted with storage compartments and carrying handle. Size 13 x 10 x 7in. High quality record-replay amplifier with internal loudspeaker provides immediate high quality reproduction. ★ Socket for external speaker. ★ Tone control: Supplied with reel of tape, empty spool, microphone and a selection of interconnecting leads, etc., with canvas waterproof cover. Brand New and Unused. Carr. and Ins. 10/6.

LASKY'S PRICE 24 gns.

Get ready NOW for the NEW TV frequencies

Lasky's first again with a U.H.F. Tuner. Complete with P.C. 88 and P.C. 86 Valves. Fully variable tuning capacitor, etc. British manufacture. New and unused size 4¼ x 5¼ x 1½in. Complete with valves. **29/6** P. & P. 2/-

CRYSTAL PICK-UP CARTRIDGES

Lowest Prices Ever!

All complete with Styli, L.P. and Standard (and Stereo where shown). Fully guaranteed, standard fitting, will fit most P.U. arms and heads.
Postage 1/- each extra.

MONO

TYPE C.T.1. By well known manufacturer. With two sapphire styli	12/6
Garrard GCE.4	15/-
Ronette Studio O	15/-
Acos GP.65/3	15/-
Acos GP.65/1	17/-
Acos 67/1	17/-
Acos GP.61/1	18/-

STEREO

Acostereo 73/1 with two sapphires	25/-
Acostereo 73/2 with Diamond L.P./Stereo and sapphire Std.	28/6
Collaro type C. Turnover, with 2 sapphires	25/6
Collel S.C.1. Turnover with 2 sapphires	24/6
Collel S.C.1. Turnover with Diamond L.P./Stereo and sapphire Std.	29/6
Ronette Stereo O.V. Turnover, with 2 sapphires	29/6
Ronette Stereo type 105, with 2 sapphires	35/6
Ronette Stereo type 105, with Diamond L.P./Stereo and sapphire Std.	39/6

Distler Miniature Motors

6 volt battery operated 7/11. P. & P. 2/6.

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BOTH OPEN ALL DAY SAT Early Closing Thurs. Mail Orders to Dept. P.W., Edgware Rd.

Volume Controls

Linear or Log Tracks Long spindles. Midget 5 K ohms to 2 Meg. L.S. 3/-; D.P., 4/6; Stereo L/S 10/6: D.P. 14/6

80 ohm CABLE COAX

Semi-air spaced ¼in. Stranded core. 40 yds. 17/6 60 yds. 25/- **6d.yd.**

Fringe Quality Air spaced **1/-yd.**

TELESCOPIC CHROME AERIALS. 13in. extending to 43in., 8/6 ea. Coax Adaptor Plug, 1/6 extra.
TRIPLEXERS Bands I, II, III 12/C
COAX PLUG .. 1/- **LEAD SOCKET** .. 2/-
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BALANCED TWIN FEEDER yd. 6d. 80 or 300 ohms.
DITTO SCREENED per yd. 1/6. 80 ohms only.
Wirewound Ext. Speaker Control, 10Ω 3/-, 25Ω 6/6.
WIRE-WOUND POTS. 3 WATT. Pre-set Min. TV Types. All values to 10 ohms to 25 K., 3/- ea. 30 K., 50 K., 4/-. (Carbon 30 K. to 2 meg., 3/-).
WIRE-WOUND 4 WATTS Pots. Long spindle. Value, 50 ohms to 50 K., 6/6; 100 K., 7/6.
PHILIPS TRIMMERS. 0-10 pF, 3-30 pF, 1/-.
TRIMMERS. Ceramic. 30, 50, 70 pF. 9d.; 100 pF, 150 pF, 1/3; 250 pF, 1/6; 500 pF, 750 pF, 1/9.
TV etc. **TRIMMER.** 1000 pF, with knobs, 2/-.
RESISTORS. Preferred values. 10 ohms to 10 meg., ¼ w., 4d.; ½ w., 4d.; 1 w., 6d.; 1½ w., 8d.; 2 w., 1/-. High Stability. ½ w., 1%, 2/-. Preferred values 10Ω to 10 meg. Ditto 5% 10Ω to 22 meg., 9d.

WIRE-WOUND RESISTORS 10 ohms—10,000 ohms

5 watt	1/3
10 watt	2/-
15 watt	2/-
12.5K to 47K 10 w.	3/-

AMERICAN "BRAND FIVE" PLASTIC RECORDING TAPE

			Spare Plastic Reels
Double Play	7in. reel, 2,400ft.	60/-	
	5in. reel, 1,200ft.	37/6	
Long Play	7in. reel, 1,800ft.	35/-	3in. 1/6
	5¾in. reel, 1,200ft.	23/6	4in. 2/-
	5in. reel, 900ft.	18/6	5in. 2/-
Standard	7in. reel, 1,200ft.	25/-	5¾in. 2/-
	5in. reel, 600ft.	16/-	7in. 2/6

"Instant" Bulk Tape Eraser and Head Defluxer, 200/250 v. A.C., 27/6. Leaflet with full details, S.A.E.

CRYSTAL SET BOOKLET, 1/-.
CRYSTAL DIODE G.E.C., 2/-, GEX34, 4/-. OA81, 3/-.
HIGH RESISTANCE PHONES. 4,000 ohms, 15/- pr.
SWITCH CLEANER. Fluid squirt spout, 4/6 tin.

HIGH GAIN TV PRE-AMPLIFIERS BAND I B.B.C.

Tunable channels 1 to 5. Gain 18dB. ECC84 valve. Kit price 29/6 or 49/6 with power pack. Details 6d. (PCC84 valves if preferred). Coils only 9/6.

BAND III I.T.A.—Same prices. Tunable channels 8 to 13. Gain 17dB. Circuit and Coils only, 9/6.

1/16in. **Paxolin Panels,** 10 x 8in., 2/-.
Miniature Contact Cooled Rectifiers. 250V 50mA, 7/6: 250V 60mA, 8/6: 250V 85mA, 9/6; **Selenium Rect.,** 300V-85mA, 5/-.
TV etc., Silicon Sub.Min. Rectifier, 125V, 300mA, 6/6: 250V, 450mA, 10/-.
RM4, RM5, 14A100 14A116, 10/-each. FC31, 20/-
Coils Wearite "P" Type, 3/- each.
Osmor Midget "Q" type, adj. dust core, from 4/- each. All ranges. List S.A.E.
Teletron D.W.R. L. and Med. T.R.F. with reaction, 4/-. Med. wave D.R., 3/6.
Ferrite Aerials, M., 8/9: M. and L., 12/6.
Osmor Ferrite Rod Aerials, L. and M. for transistor circuits, 10/- each.
Ferrite Rods, 8 x ⅜in., 3/-.
H.F. Chokes, 2/6. **Osmor QCI,** 6/9.
T.R.F. Coils. A/HF, 7/- pair; HAX, 3/-, Repanco DRR2, 4/-. DRX1, 2/6.
Radio Screwdriver, 5in., 6d.
Neon Mains Tester Screwdriver, 5/-.
Solder Radiograde, 4d. yd., ½lb. 5/-.
Black Crackle Paint. Air drying, 3/- tin.

Aluminium Chassis, 18 s.w.g Plain undrilled. 4 sides, riveted corners, lattice fixing holes, 2½in. sides, 7 x 4in. 4/6: 9 x 7in., 5/9: 11 x 7in., 6/9: 13 x 9in. 8/6: 14 x 11in., 10/6: 15 x 14in., 12/6: **Aluminium Panels,** 18 s.w.g., 12 x 12in., 4/6: 14 x 9in., 4/-: 12 x 8in., 3/-: 10 x 7in., 2/3: 8 x 6in., 2/-.

"6 + 1" TRANSISTOR RADIO MEDIUM AND LONG WAVE KIT

First class components to make a 6 transistor 2 waveband superhet chassis. Ideal for portable or table radio. All parts including BVA transistors, ferrite aerial, *with car aerial coil*, printed circuit. 8½in. x 2¾in., but EXCLUDING speaker and cabinet. **£4.5.0**
Speakers, 35 ohms, 7 x 4in. 21/- 5in., 17/6, 3½in., 15/6.

BULGIN PLUGS AND SOCKETS. Non-reversible P74, 2-pin, 4/3; P73, 3-pin, 4/6; P194, 6-pin, 5/6.
JACKS. English open circuit, 2/6. Closed circuit, 4/3, Grundig type, 3-pin, 1/3. Grundig lead jack, 3/6.
JACK PLUGS. English, 3/-; Screened, 4/-; Grundig, 3-pin, 3/6.
ALADDIN FORMERS and cores, ¼in., 8d.; ⅜in., 10d. 0.3in. **FORMERS** 5937 or 8 cans TV1 or 2, ⅝in. sq. x 2½in. or ½in. sq. x 1¼in. 2/- with cores.
SLOW MOTION DRIVES. 6 : 1, 2/3.
SOLON IRON, 25W, 200V or 230V, 24/-.
ANTEX SUB-MIN IRON 15w. 200 or 240 v., 29/6.
BENCH STAND for above 12/6.

JASON FM TUNER COIL SET 29/-. H.F. coil, aerial coil, oscillator coil, two i.f. transformers 10.7 Mc/s. detector transformer, heater choke. Circuit book using four 6AM6, 2/6.
Complete Jason FMT1 Kit. Jason chassis with calibrated dial, components and 4 valves, £6.5.0.
Model FMT2 with new shelf cabinet, 5 valves & power pack £10. Less power £8.15.0.

MAINS DROPPERS. Midget adjustable sliders 0.3A. 1,000 ohms, 5/-; 0.2A, 1,200 ohms, 5/-; 0.15A, 1,500 ohms, 5/-; 0.1A, 2,000 ohms, 5/-.
MIKE TRANSFORMER. 50-1, 3/9.
P.V.C. Covered Wire, single or stranded, 2d. yd. Sleeving, 1 or 2 mm., 2d.; 4 mm., 3d.; 6 mm., 5d. yd.
SPEAKER-FRET. Gold Cloth 17 x 25in., 5/-; 25 x 35in., 10/-. Tygan, various colours, 52in. wide from 10/- ft.; 26in. wide from 5/- ft. Samples, S.A.E. Expanded Metal, Gold, 12 x 12in., 6/-.

RADIO AND TELEVISION SPARES

All leading makes, volume controls, etc., line output transformers, etc., B. V. A. valves, (current and obsolete types). Send S.A.E. for quotation.

WEYRAD

COILS AND TRANSFORMERS FOR 2-WAVE TRANSISTOR SUPERHETS WITH PRINTED CIRCUIT AND FERRITE ROD AERIAL

Long and Medium Wave Aerial—RA2W On 6in. rod, 208pF tuning, with car aerial coupling coil	12/6
Osc. Coil P50/1AC, 176pF tuning.	5/4
1st and 2nd I.F. Trans.—P50/2CC, 470kc/s 11/16in. dia. by ⅞in.	5/7 each
3rd I.F. Trans.—P50/3CC.	6/-
Spare Cores	6d. each
Driver Transformer—LFDT4.	9/6
Wavechange Slide Switch.	3/6
Printed Circuit—PCA1. Size 2⅝ x 8½in. Ready drilled, and printed.	9/6
Volume Control, 5K-DP.	4/6
35 ohm Speakers, 3½in., 15/6; 5in., 17/6; 7 x 4in., 21/-.	
24 Fixed Resistors.	10/6
16 Fixed Condensers.	21/-
Tuning Gang with trimmers.	10/6
6 Mullard Transistors and diode.	42/6
Constructor's Booklet.	2/-

NEW MULLARD TRANSISTORS OC71 6/-, OC72 7/6, OC81D 7/6, OC81 7/6, OC44 8/9, OC45 8/6, OC171 10/6, AF117 9/6

Sub Miniature Condensers. 0.1 mFd, 30 v. 1/3. 1, 2, 4, 5, 8, 16, 25, 30, 50, 100 mFd, 15 volt 2/6 ea. Transistor Holders 1/3.

B.B.C. Pocket 2 Transistor. M.W. and L.W. Radio Kit, 22/6. Miniature earpiece, 7/6. Batt. 2/3. Circuit details, etc., S.A.E.

MONARCH RECORD PLAYER

Kit with ready built amplifier, speaker and cabinet.
carr. and ins. 5/- **£11.10.0**

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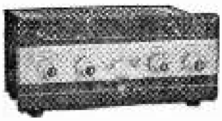

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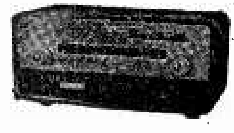

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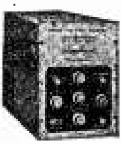
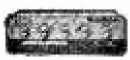


SB-10U



USC-I

TA-IS

S-99

AM/FM Tuner

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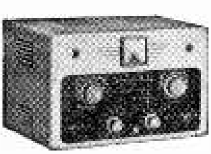

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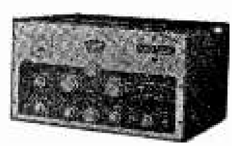

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Practical Wireless

Vol. XXXIX No. 675 MAY, 1963

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PRACTICAL WIRELESS

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Contents

Something for Everyone

IT is a truism that you cannot please everyone; that in attempting to do so you inevitably end up by pleasing nobody. For in striking any compromise between conflicting interests each loses part of its substance so that, in the event, such a solution is not entirely satisfactory to anyone.

These thoughts result from a recent question on the requirements of the average PRACTICAL WIRELESS reader. The fact is, of course, that there *is* no average reader, but a great many types of reader.

Coming back to the opening paragraph it is obvious how difficult it is to strike a reasonable balance when planning issues without making compromises that leave everybody unsatisfied!

There are those who like building radio sets. There are audio fans. There are those interested in test gear. Some like electronic gadgets and novelties. Others want theory articles.

Each of these main groups can easily be sub-divided. Whereas, for instance, one reader wants valve circuits, another will prefer transistor designs. Where one reader wants high quality local station sets, another will be more interested in sensitive short wave receivers.

And to complicate matters further, the readership of PRACTICAL WIRELESS embraces the whole scale of enthusiasts from the raw beginner to the experienced constructor and experimenter.

It will be obvious that the number of permutations possible makes it extremely difficult to produce issues of sufficient variety to take in all types of article required to suit varying degrees of knowledge and yet with something to please the specialists.

If you do not see an article to suit your particular requirements in any one issue, we hope you will bear these facts in mind! For a fair assessment of coverage, an issue taken at random is no criterion. The balance may be one way in one issue, but more heavily biased in another direction in the next issue. Overall, in a series of issues, it will be found that most interests get a fair share of the space.

Even taking one issue in isolation, we attempt the impossible! In this issue, for instance, there are two radio receivers—a simple set suitable for the beginner and a multivalve communications receiver for the advanced constructor. For audio fans there is the concluding article describing a hi-fi radiogram. Test gear enthusiasts have a useful test oscillator. Two articles are angled towards the interest in electronics—the geiger counter digital register and a photo-flash unit. The two theory articles are not merely text-book material but informative text of practical merit. And there are three unclassified articles to add a spice of variety.

We are always extremely interested to receive suggestions (and criticisms!) from readers on the contents of the magazine as this helps considerably in deciding on the balance. For while it probably cannot be done, we will always strive to maintain a compromise that *will* please everyone!

Our next issue dated June will be published on May 7th.

ROUND THE WORLD of WIRELESS

NEWS AT HOME AND ABROAD

Broadcast Receiving Licences

THE following statement shows the approximate number of Broadcast Receiving Licences in force at the end of January, 1963, in respect of wireless receiving stations situated within the various Postal Regions of England, Wales, Scotland and Northern Ireland. The numbers include Licences issued to blind persons without payment.

Region	*Total*
London	604,581
Home Counties	563,923
Midland	411,197
North Eastern	428,807
North Western	368,393
South Western	335,057
Wales and Border Counties	184.832
Total England and Wales	2,896,790
Scotland	303,572
Northern Ireland	103,736
Grand Total	3,304,098

Travelling Wave Tubes for Canada

THE firm of R.C.A. Victor Company of Montreal has placed an order with Mullard Ltd. for travelling wave tubes to be used in a 3,300 mile Montreal-Vancouver microwave communications link for which R.C.A. Victor is supplying the radio equipment.

Success with New Laser

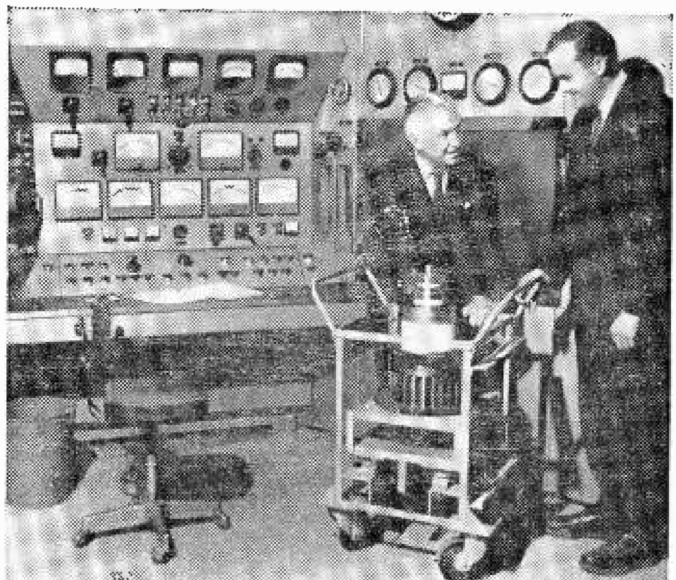
SCIENTISTS at Standard Telecommunication Laboratories in Harlow, Essex, recently succeeded in making their version of a new kind of laser work for the first time.

The new laser is the result of months of research into the semiconductor gallium arsenide, and first experiments produced line narrowing, the threshold effect and space coherence together with polarisation effects—all the criteria of successful laser action.

Big Valve Tester for Big Valves

THE huge vapour-cooled transmitting valves, built by the Machlett Laboratories Division of the Raytheon Company for the Voice of America's newest station in North Carolina, required the construction of a special large-size valve tester. This was built to Machlett's specifications by the Votator Division of Chemetron Corp., and can deliver continuous power of 1,200,000W.

Special safeguards were built into the tester to short-circuit the tube being tested in ten-millionths of a second and thus protect it should trouble develop. The tester corrects faults in less than a hundredth of a second, so that power surges are unnoticed elsewhere in the plant or in the adjoining community, while a copper cage around the tester shields the high frequency radio emissions and prevents radio or television interference in homes nearby.



A Machlett vapour-cooled valve being wheeled inside its giant valve tester.

Over 400 Miles of Wiring

FOR the complete rewiring of the electrical system in the Royal Albert Hall, London, some 750,000 yards—or over 400 miles—of cables of various types were manufactured and supplied by British Insulated Callender's Cables Limited. This scheme, which has been carried out progressively over the last ten years and is now completed, also involved improvements and additions to the old system, certain sections of which had not been rewired since 1908.

The demands on the Hall's electrical system are numerous and varied by the very nature of the different kinds of events which are held there. For example, in addition to normal lighting and power, separate services are required for the control organ blower, the BBC's control room on the Balcony floor, TV and film lighting facilities, for special effects lighting round the Gallery and under the Arena floor.

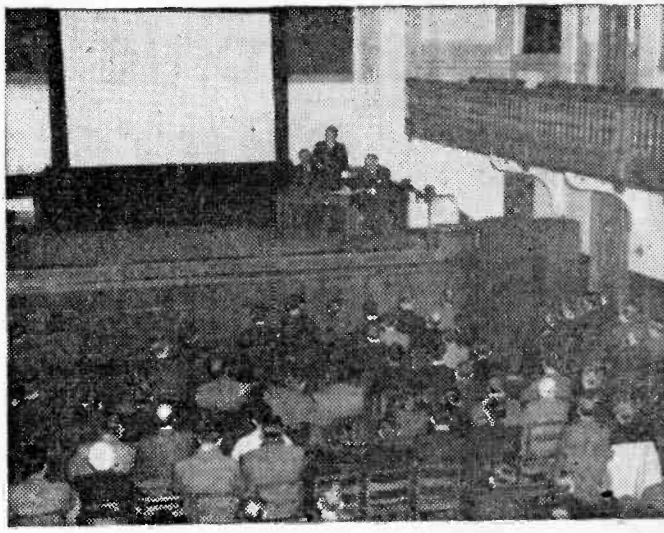
Where formerly there was one a.c. mains supply intake there are now two—the original one on the north side, still served by one 200kVA feeder, and a new intake switchroom on the south side containing six similar feeders.

Advances in Radar Techniques

A DEVELOPMENT in radar techniques, which, if applied to existing civil and military air traffic control systems, would considerably speed operations, was recently announced by the Marconi Company.

Following original research at the Marconi Laboratories by C. Cockerell and C. D. Colchester, research, which has been going on for the past six years at the Marconi Research and Development Laboratories, has resulted in the design of a special type or radar aerial head.

The "secret" of the new techniques lies in the fact that, unlike conventional equipments, the transmission does not take place on one fixed frequency but is swept through a band of frequencies for the purpose of height-finding. This, in conjunction with the new aerial, has the effect of electronically tilting the transmitted beam through an arc in the vertical plane and thus obviates the need for the mechanical movement of the whole aerial head, as in the current operational practice.



Part of the audience at the recent P.W. film show.

The new system confers at least two important advantages. It enables height-finding, range and bearing information to be derived from one radar instead of the two conventionally employed, and, perhaps even more important, it can provide height information at a very much faster rate than is possible with present equipment.

New Cable Ship Ordered

A DIESEL-ELECTRIC cable maintenance ship of about 4,300 gross tons has been placed on order by Cable and Wireless Ltd. The new ship will be capable of handling all types of submarine cable, including telephone cable with submarine amplifiers inserted.

She will be fully air-conditioned to work in tropical waters as well as temperate climates and will have a cable capacity of 30,000cu. ft or 350 miles of lightweight coaxial cable.

Conference on Microwave Valves

THE Electronics Division of the Institution of Electrical Engineers is organising a conference on the design and use of microwave valves which will be held at the institution headquarters at Savoy Place, London, W.C.2, from Wednesday, October 16th, until Friday, October 18th, 1963.

This conference aims at providing a meeting point for the requirements of the system's designer and the possibilities held out by the valve engineer.

The proceedings of the conference will fall into three main headings: signal amplification and physical measurements, radar and communications and industrial applications and it is evident from the many contributions already offered that amplification, millimetre waves, microwave relay systems, radar modulators and duplexing systems will be dealt with. Also attention will be given to such devices as linear beam valves, travelling wave tubes, klystrons and crossed field valves, all of which are of particular importance in radar and its allied applications.

Tape-Recording Equipment for Beirut

THE new Beirut commercial recording studios of Levant Forlkloric Arts Ltd. will shortly be taking delivery of a five-channel audio mixing control console, two TR90 stereophonic tape recorders and ancillary studio equipment from EMI Electronics Ltd.

Main use of the equipment will be for producing master recordings on magnetic tape for broadcast commercials, feature programmes, general copying and dubbing.

The mixing unit provides the means to control and mix the outputs from up to four microphones and one line level source into one common output, and includes full monitoring and talk-back facilities.

electronic PHOTO FLASH UNIT

BY C. M. FRETTER

MANY readers of this magazine have as a second hobby one which has greatly increased in popularity over the past few years; namely, photography. All such readers will recognise the value of an electronic photo-flash unit, permitting the taking of indoor flash pictures without the expense of flash bulbs which cost about a shilling per photograph. The running cost of the equipment about to be described is negligible.

This unit is constructed using modern semi-conductor devices which can be easily obtained for a reasonable price. It is, therefore, very reliable and once built should give long and faithful service with little or no maintenance. It has a power output of 75J and a recycling or recharging time of about 12 seconds.

CIRCUIT

The circuit (shown in Fig. 1) is quite simple and comprises a d.c. converter of the push-pull transistor type feeding energy to the storage capacitor C2, which is discharged through the flash tube FT1 when a high voltage pulse is present at the trigger electrode.

The trigger voltage is obtained by switching capacitor C3, which has become charged through R6 from the main h.t. supply, across the primary of T2. C3 now discharges through the primary of T2, which, having a high step up ratio, produces the necessary 4-5kV pulse at the trigger electrode.

TRANSFORMERS

Both transformers for this unit may be made without any special tools, and providing a little care is exercised in construction, a really good job can be achieved. Materials required to make these transformers are shown in Table 1.

¾in. high stack of 'Mumetal' laminations having a centre limb size of approximately ¾in. x 1¼in.
Piece of ferrite rod ⅜in. dia. x 1¼in. long.
Cardboard to make formers.
20ft. 18s.w.g. enamelled copper wire.
20ft. 30s.w.g. enamelled copper wire.
4oz. reel of 38s.w.g. silk covered enamelled copper wire.
10ft. 30s.w.g. silk covered enamelled copper wire.
Small reel Sellotape or similar adhesive tape.
A small length of insulating paper cut to fit the width of the cardboard bobbin for T1.
2 yards of Empire Tape cut as above paper.

TABLE 1

CONVERTER TRANSFORMER

The secondary winding of T1 (1,840 turns) is wound in two sections of 920t, the two primary windings being sandwiched between them (see Fig. 2). These windings must be wound on carefully, the ends fixed with adhesive tape and brought out through holes drilled in the cardboard former.

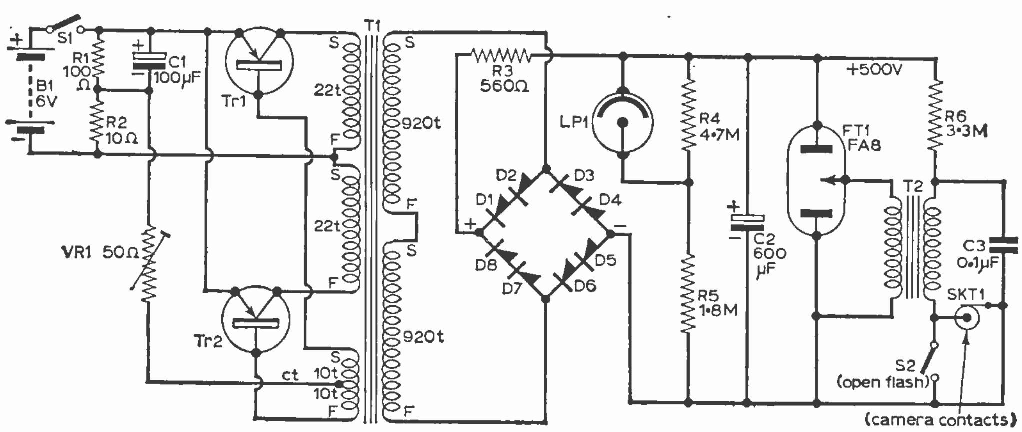


Fig. 1 The circuit diagram of the unit.

COMPONENTS LIST

Resistors: (All ½W carbon)
R1 100Ω R3 560Ω R5 1·8MΩ
R2 10Ω R4 4·7MΩ R6 3·3MΩ
VR1 50Ω pre-set potentiometer w.w.

Capacitors:
C1 100μF electrolytic 12V
C2 600μF electrolytic 500V (Daly PFM66/28)
C3 0·1μF 500V

Transistors:
Tr1, Tr2 OC28, OC29 or OC35

Miscellaneous:
FT1 FA8 flash tube; SKT1 coaxial socket; LP1 neon lamp (striking voltage 190); S1 on/off switch; S2 press "on" push button switch; B1 three portable accumulators (Exide MFB9); D1 to D8 silicon rectifiers ZS73 or SX632; T1 and T2 see text.

The primary winding of 22+22 turns is wound in a special manner known as bifilar winding. This is achieved by taking two lengths of wire and winding them on simultaneously side by side to form a flat layer one wire thick across the length of the former. If 22 double turns cannot be accommodated in this length on the core you have obtained, part of a second layer may have to be wound over the first. As with the secondary windings the ends must be fixed with adhesive tape and brought out through holes drilled in the former.

The second primary winding of 10+10 turns may be wound as 20 turns tapped in the centre, the tap being brought out through yet another hole in the bobbin. This winding will go on in one layer and is therefore fairly easy to wind. The ends are fixed and brought out as before.

The second half of the secondary is then wound on it in the same way as the first half. Between every winding and the next two layers, insulation in the form of Empire Cloth is wound on the end fixed with adhesive tape.

TRIGGER PULSE TRANSFORMER

This transformer is much simpler to wind, the whole operation taking only about an hour. The primary winding of 85t is wound on to the card former so that it occupies a few layers along the whole length of the former. The ends of the windings are fixed with adhesive tape and brought out through holes drilled in the former.

The secondary winding is wound over the primary, the ends fixed with adhesive tape and brought out through holes drilled in the former. To assist in winding on this large number of turns quickly, a wheel brace having a high gear ratio may be used. It is only necessary to count the handle revolutions and multiply by the gear ratio to arrive at the number of turns wound.

MECHANICAL CONSTRUCTION

It is not intended to lay down a fixed method of construction for this unit as most constructors will have their own ideas about cases in which to mount the completed equipment. There are, however, a number of design features which should be closely followed when the unit is built.

The transistors Tr1 and Tr2 should be mounted on a pair of heat sinks having a total surface area of approximately 18 sq. in. each. These are made from $\frac{1}{16}$in. thick aluminium and are therefore to be approximately 3in. x 3in. The transistors must be mounted in the centre of these sheet heat sinks and the heat sinks must be insulated from all other components in the unit.

When mounted in a case, ventilation should be provided so that the heat sinks remain cool. The cases of the transistors specified are the collector connections and therefore solder tags must be provided to fit under the heads of the fixing bolts.

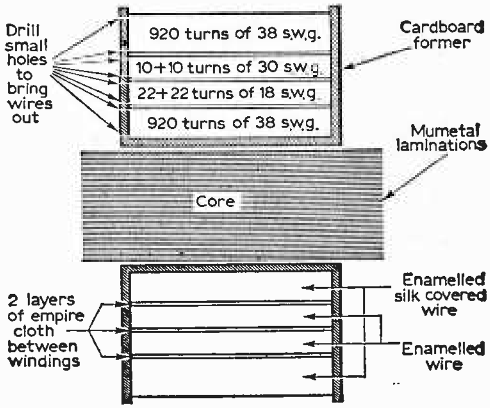
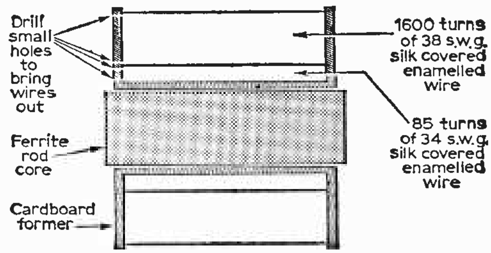


Fig. 2 (above): A section through T1.

Fig. 3 (below): The windings of T2.



OPERATING INSTRUCTIONS

Before switching-on for the first time, an ammeter should be connected in series with the battery. With the switch S1 closed, the current should rise to a maximum value and RV1 should be adjusted to limit this value to 4A.

When C2 is fully charged LP1 lights up and then the unit is ready to be fired. The camera is then connected to SKT1 and as the shutter is released, or as the open flash button, S2, is closed, the flash tube strikes, giving a high intensity flash.

WARNING

Since the potentials encountered in this equipment are dangerous it is advised that all wiring on and after the secondary of T1 should be adequately insulated to prevent accident.

TEST GEAR techniques

PART 4 - A.M. SIGNAL GENERATORS

H. W. Hellyer

SIGNAL generators, nowadays, vary from the pocket-sized test source, to sophisticated instruments with very close standards, choice of modulation, and built-in measuring devices. The instruments we shall consider are those which provide a controlled signal source over a particular range of frequencies.

The types are: radio frequency signal generator, with variable frequency and amplitude, modulated by a fixed audio tone; the audio generator, and the frequency modulated sweep oscillator, or "wobbulator".

Modern instruments of the r.f. type usually cover a range of frequencies from the broadcast intermediate frequencies to the television bands. Thus, a coverage of from 100kc/s to 250Mc/s may be quoted in the specifications.

But what is important to the service engineer is the accuracy of the signal. in terms of output voltage as well as frequency. Many instruments described as signal generators are no more than ambitious test oscillators—very useful in their own right, but without the known depth of modulation, frequency stability and output regularity of the true sig. gen.

At the upper frequencies, where such accuracy is more difficult to obtain, it is all the more important. Some instruments, rated at 200Mc/s output, for example, rely upon the harmonics of the basic oscillator from above 100Mc/s. Using these harmonics can be more exacting, and misleading results are possible unless the user is wholly accustomed to his test gear.

For the amateur, who may have recourse to the signal generator only occasionally, as a frequency check, or to align a piece of equipment he has built, the "simple" test oscillator has its pitfalls.

Colpitt's Oscillator

The standard signal generator has, first, a frequency generating source, variable in switched ranges to give as wide as possible a sweep of the dial cursor. A common circuit is the well-known Colpitt's oscillator, such as illustrated in Fig. 17a.

Here, a.c. is coupled back to the tuned circuit, which consists of a pair of variable capacitors (which may be a single, tapped unit) C1 and C2, across the coil L. The reactance of the coil and the two capacitors determines the oscillator frequency.

The feedback, via Cf is across the load of C2, and the voltage is determined by the ratio of C1 to C2. The phase of the feedback is correct for maintaining oscillation, as the anode and the grid of the triode valve V1 are connected, virtually, to opposite ends of the tuning coil.

By switching various coils into circuit, and altering the values of the tuning capacitors by adding presets, a wide range of frequencies is attainable.

Hartley Oscillator

Another widely used circuit, which needs only the one tuning capacitor, and lends itself to easier construction, is the Hartley, as in Fig. 17b. In this oscillator, the coil is tapped to form L1 and L2, the feedback being via Cf, across L2, with C1 acting as the tuning capacitor.

In each case, the output is taken from the anode circuit, and a modulating signal can be coupled to the load to give the minimum shunting effect to the oscillator. This is easy to state, but not always so easy to design and build, and several refinements will be found in the commercial instrument.

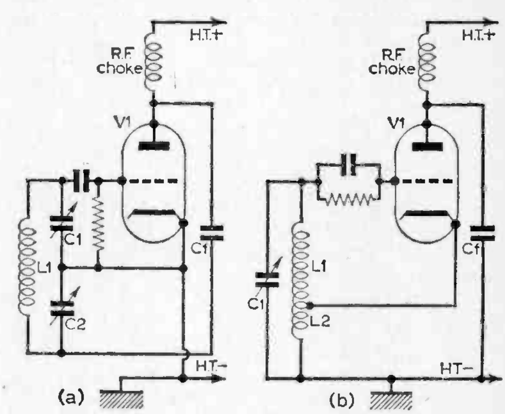


Fig. 17a: Colpitt's oscillator; b: the Hartley oscillator.

The output, with its modulation, is fed to an attenuator, to enable controlled amplitude of applied signal. Obviously, the amount of r.f. applied to the attenuator must be constant, despite the different settings of the output loading, and so it is necessary to have a "Set Carrier" control, and, preferably, some means of monitoring the signal.

In addition, although the depth of modulation is fixed, usually at about 30%, it is an advantage to make the instrument more versatile by varying the modulator through the audio range of frequencies.

In either case, a separate output is required for audio frequencies. Another output socket is connected to the high level part of the oscillator circuit to give a full r.f., which can be very useful for forcing a signal through a completely misaligned receiver.

Basic Generator

We now have an instrument something like the block diagram of Fig. 18, with a "high r.f." and "attenuated r.f." output, plus an "audio" output, with a switch that has three positions.

The first position gives an unmodulated r.f., a carrier wave, or c.w., the second position a c.w. which is now modulated, (m.c.w.), to a depth of 30% by the a.f. oscillator at a fixed frequency, and a third position giving a variable audio output, both in frequency and level.

Also incorporated is a monitoring device, which may be a simple meter, or a valve-voltmeter circuit that can further extend the usefulness of the instrument, and an attenuator that is continuously variable by switched steps and intermediate variable control.

Before discussing the applications of such an instrument it may be as well to mention the added facility of a crystal controlled check source, and to say a bit more about the attenuator.

The accuracy of the signal generator can be checked against an external standard, such as a broadcast signal. But this is not always convenient, and by far the best alternative method is to beat the basic signal of the signal generator with the output of a crystal controlled oscillator, and calibrate by tuning for a null point, either by metering or by listening in headphones.

Crystal Oscillator

The crystal controlled oscillator, either as the basis of a beat frequency oscillator or as a wavemeter, will be considered in more detail at a later stage.

The principle is simple enough: a crystal of quartz or Rochelle salts has a piezo-electric effect, a familiar example being the action of a pick-up cartridge of a gramophone. A varying pressure applied to two faces of a block of crystal will produce a varying voltage across those faces.

Further, an alternating voltage applied to the faces (by means of metal plates in close contact) will cause the crystal to vibrate. According to the dimensions of the block of crystal, the thinner the block, the higher the natural frequency of vibration, a compact unit of exceptional stability can be made, with a set fundamental frequency.

An oscillator circuit, built around this unit, has the advantage of a fixed and stable frequency, rich in harmonics, of high output power, and—what is important—its frequency is not affected by changes in loading.

Such a circuit is shown in Fig. 19a. This is the crystal equivalent of the simple TATG oscillator, with a pentode valve, connected as a triode to obtain a high grid-anode capacitance for greater feedback.

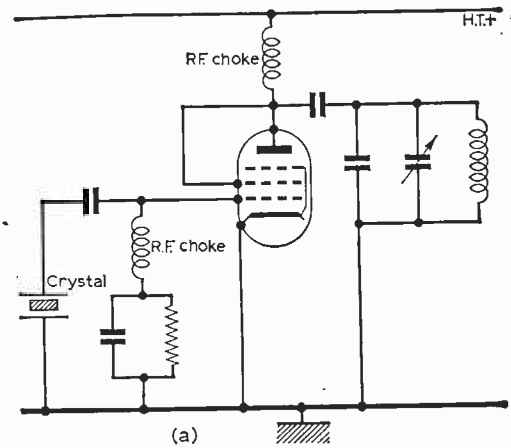
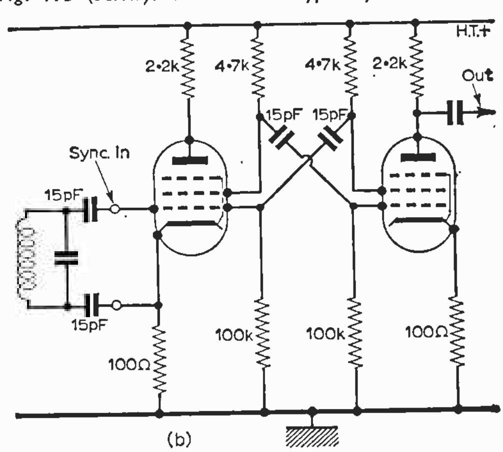


Fig. 19a (above): A simple crystal oscillator circuit.

Fig. 19b (below): The Franklin type crystal oscillator.



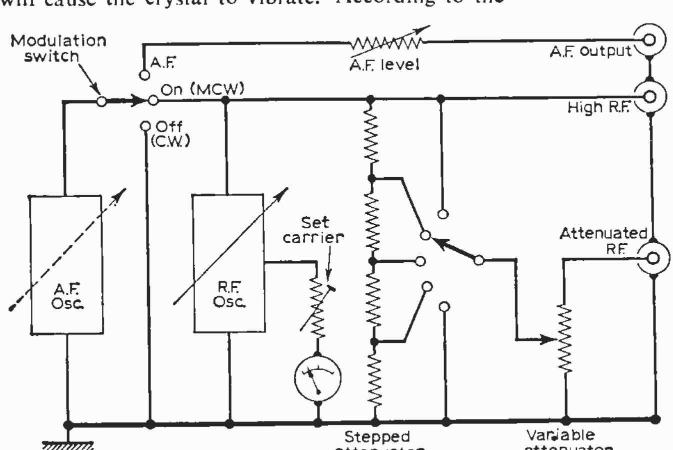


Fig. 18: The basic generator circuit.

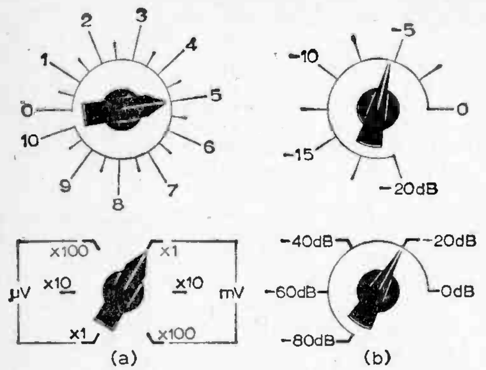


Fig. 20: Two examples of attenuator control markings.

The anode circuit is made variable, and, in fact, is normally tuned to a higher frequency than the crystal fundamental, to achieve better stability of operation. But for the purpose of calibrating a signal generator, it is better to use a circuit a little more refined.

The Franklin type crystal oscillator of Fig. 19b has several advantages. Its natural frequency can be arranged as very nearly the fundamental frequency of the crystal—in this case 100kc/s. When the crystal is lightly coupled to the input terminals, the multivibrator locks into step, producing a square waveform, rich in harmonics.

Unless the signal generator is drastically out of calibration, it should be easy to tune in to a number of points throughout the normal i.f. and broadcast range, and assess the accuracy of the signal generator tuning. If a calibrator of this type is constructed, care should be taken to keep circuit capacitances to a minimum. Normal accuracy of calibration is ±1%.

The Attenuator

The attenuator is an extremely important part of the signal generator circuit. Normally, the r.f. output of the signal generator is in the region of 100mV. This is available at the "high r.f." output socket, but for alignment, stage gain checking and other tests, it is necessary to reduce this output in measured steps.

Thus, the attenuator is usually designed to give, say, 20dB steps, with a variable control of similar amount, to give a completely variable reduction from maximum to minimum, with the controls marked in such a way that this reduction can be read off as a relative voltage to the output of the instrument.

For an instrument with dB steps, a setting of −20dB of the step attenuator and full minimum, i.e. −20dB of the variable attenuator produces 20+20dB attenuation. This is one hundredth of the r.f. output voltage, so the terminal voltage is 1mV if the full r.f. is 100mV.

But the voltage step controls are usually marked as "multipliers", with the ×1 position as the lowest output. This may be an equivalent of 1µV, and each step may be a ×10 increase, with the variable control also ×10.

So a similar reading (1mV) would be obtained when the controls were in the "Microvolts ×100" step and the ×10 setting of the fine control, or "Millivolts ×1" step and the ×1 setting of the fine control. Fig. 20 gives pictorial views of the two types of marking, set for a 5mV output.

Importance of Screening

The minimum possible output depends upon the design of the instrument, and in particular, its screening. The residual radiation from a general purpose signal generator may well be in the region of 1µV.

Thus, the lower limit of sensitivity checks is determined by the amount of signal that "escapes" from the test gear. It is therefore most important that the screening of the instrument itself and the connecting leads is not affected.

If a signal generator has been dismantled, ensure that every screw is replaced in its metal outer case—tedious though this may seem! Very often, the removable "lid" of a signal generator will be found to have a double shell, with spring clamp fitting as well as the securing screws.

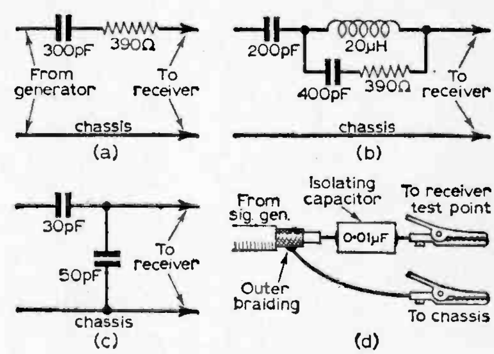


Fig. 21: "Dummy aerials."

Make certain that this spring fitting is clean and tight. If necessary, rub them down with fine sandpaper, finishing with a wipe of carbon tetrachloride to remove residual grease and dust.

The mains lead is a potent source of radiation, and mains decoupling components should never be disturbed—if, for example, a filter capacitor is replaced in a mains decoupling unit, the connections should be made off in exactly the same way as the original, and the replacement capacitor connected to the same fixing points.

Very often, it will be found that the mains lead is fed to the instrument via a feed-through capacitor. Care should be taken not to disturb this arrangement, and the "can" into which the mains filter is inserted should be effectively earthed in the correct position on the instrument.

Keep the mains lead away from the body of the instrument and from output connections.

While on the subject of output connections, it may be as well to mention probes. These are simply devices designed to match the output impedance of the signal generator, normally in the region of 75Ω, to the input circuit under test.

From this it follows that the probe will differ for various check points. It may consist of a simple series circuit of capacitor and resistor, as in

Fig. 21a, suitable for applying the signal to the broadcast receiver aerial. This is a form of "dummy aerial".

A more sophisticated version for medium frequencies is shown in Fig. 21b while Fig. 21c gives a suitable dummy aerial for matching to the aerial of a car radio, and Fig. 21d shows the input connections for i.f. alignment of an a.m. receiver.

Which brings us to the practical problem of test gear applications. The prime function of a signal generator is to provide a signal source to the equipment under test; a signal that is controlled and measurable.

The resulting output from the amplifier or radio receiver is then measured and comparisons can be made while adjustments are carried out. Perhaps the best way of demonstrating this is to run briefly through a specimen procedure of alignment.

Fig. 22 is a skeleton circuit of a conventional a.m. receiver. Using only a signal generator and an output meter, the following method of adjusting the tuned circuits for maximum response would be adopted.

Preparations for Alignment

First, connect the output meter across the output transformer, as shown. This output meter can be an ordinary a.c. voltmeter, if a specially designed instrument is not available. (Output meters will be discussed in greater detail in a subsequent article.)

Note the inclusion of the load resistor, R1. This ensures that the output transformer "sees" the correct impedance, and allows the loudspeaker to be disconnected. The fixed audio tone of the signal generator, usually 400c/s, can be wearisome.

It is interesting to note, however, that variations in output level quite clearly registered by the meter are extremely difficult to detect by ear—proof that the hit-or-miss method of aural alignment is not so effective as we delude ourselves into believing when working in haste!

It an output meter, or its substitute, are not readily available, an alternative method of reading the output level is by connecting the high resistance voltmeter or valve-voltmeter across the detector load resistance, as shown in Fig. 22.

As the tuned circuits are brought into alignment, the voltage across the detector load resistance increases. This is the rectified i.f. signal; from which it follows that an unmodulated input would also produce a voltage across the detector load.

Therefore a frequency meter or a simple calibrated oscillator can be used for alignment with this method of output registration. But meter response to the signal tends to be sluggish. A better, if less convenient, alternative is to insert a microammeter in series with the load.

The next precaution to be taken, before actually applying the signal generator, is to short-circuit the a.g.c. line, as shown at point A, *not* across the load resistor.

With some a.g.c. circuits, a simple short-circuit of this nature can upset the valve-operating conditions; this is especially true where delayed a.g.c. and stepped bias circuits are used, and in these cases it is necessary to render the a.g.c. inoperative in a different way, such as by disconnecting the anode of the a.g.c. rectifier.

Next, render the local oscillator inoperative. A simple method is to short-circuit the oscillator section of the two-gang tuning capacitor as at point B. Before doing this, ensure that there is no d.c. on the fixed plates; if so, use a 0·1μF paper capacitor to shunt the oscillator grid. Switch to the lowest frequency band of the receiver (long wave) and fully close the tuning capacitor.

Normal safety precautions must be taken. If an a.c./d.c. receiver is being tested, the polarity of the mains connection should be checked to ensure that the chassis is at "neutral" potential. Where earthing connections are available, both the signal generator and the receiver must be properly earthed.

As a final precaution, connect the signal generator to the receiver with 0·05μF paper capacitors of at least 500V d.c. rating, in both the live and the earthy lead. Avoid the danger of shocks that can be caused by touching the chassis with one hand and the generator with the other.

Connect the generator input to the mixer grid, via its isolating capacitor, switch to the appropriate frequency range, and allow both the set and the generator to warm up thoroughly—at least 15 minutes is necessary to obviate drift due to the varying capacitance of leads, components and valves when hot.

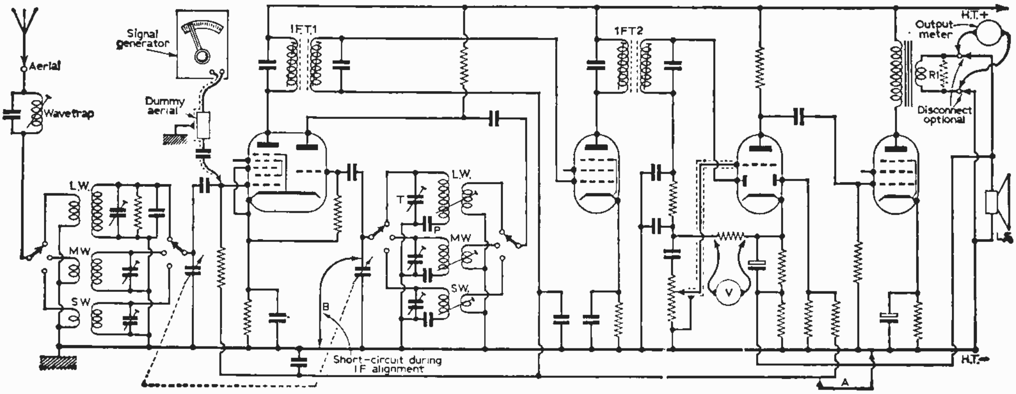


Fig. 22—A skeleton circuit of a conventional a.m. receiver.

If the correct intermediate frequency is not known, and if the set is not suspected of having been "got at", it should be possible to ascertain the correct i.f. by swinging the tuning of the signal generator around the likely range and noting the output readings, watching for an obvious peak.

I.F.'s have been settled at 470kc/s for some time now, but a few receivers may still be found whose transformers are tuned to 455 or 465kc/s. If conventional tuning is employed, a more precise method is to feed a signal of approximate frequency to the receiver, and tune the secondary of the 1st transformer, altering the input frequency, but not the level, and re-tuning until a definite peak is found.

Staggered i.f.'s, which were once common practice, are less often used in modern receivers. But care should be taken not to peak the tuning too fiercely, with the resultant danger of instability. In such cases, it is necessary to refer to the maker's published data, and tune each winding to the correct resonance point.

I.F. Alignment

Assuming that the circuit is conventional, the tuning procedure is to adjust from back to front, i.e., secondary of the second transformer, then its primary, then secondary and primary of the first transformer, for maximum output reading, reducing the input from the signal generator to the minimum workable value, to avoid overloading and possible misleading results.

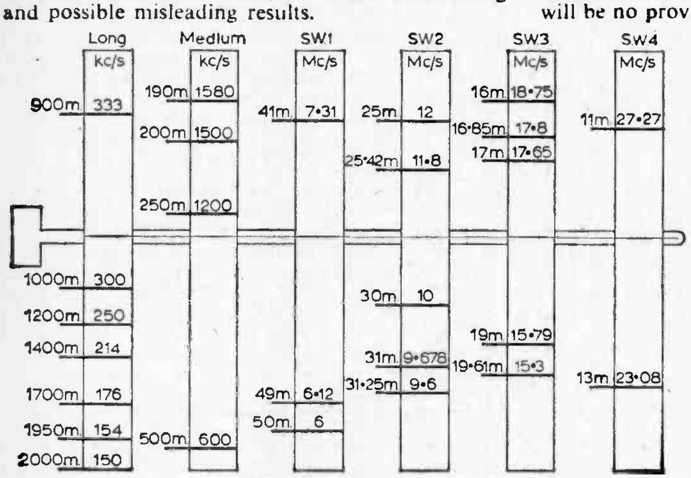


Fig. 23: Long, medium and short wave check points.

Before leaving the i.f. setting, transfer the signal generator input to the receiver's aerial and adjust the wavetrap for *minimum* output. It will probably be necessary to force the full r.f. input, via the dummy aerial, to obtain any breakthrough.

R.F. Alignment

With the signal generator input, via the dummy aerial, connected to the receiver's input (aerial and earth) sockets, next tune the oscillator and aerial circuits in the following sequence.

Switch to long wave, tune to a convenient point near the high frequency end of the band, and adjust the oscillator trimmer T (Fig. 22) for the correct frequency. Where two "peaks" are found, adjust to the outer, (i.e., the first peak reached when screwing the plates of the trimmer T from the open towards the close position).

Adjust the long wave aerial trimmer for maximum output, without altering the frequency setting of either generator or receiver.

Retune to the low frequency end of the band, and adjust the slug of the oscillator coil, or, where fitted, the padding capacitor D. It may be necessary to "rock" the dial of the signal generator through a few kc/s while making this adjustment, to find the position of best output. Then return to the high frequency end of the band and check the calibration, re-trimming if necessary, finally re-checking the aerial circuit alignment again for maximum output.*

On medium waves, a similar procedure is followed. First, trim the h.f. end of the band, then pad or tune the coil at the low frequency end, returning to the h.f. end for minor re-setting. Throughout these operations, the generator output should be progressively reduced to avoid overloading.

At the high frequency end, the trimmer has the most effect, and at the low frequency end of each band, the coil core or padder should be adjusted—always returning to the h.f. end for a re-check.

Many modern receivers do not use padders on medium and short wave bands, and often there will be no provision for coil tuning on short waves; the calibration having been carried out at the factory by adjustment of the spacing of the coil turns.

On a number of models, calibration check points are marked on the scale pan, dial drum or the dial itself, and should be used. But for general guidance, a scale of Long, Medium and Short Wave check points, in wavelength and frequency, is given in Fig. 23.

This by no means exhausts the subject of alignment, or the description of signal generator applications. More will be said when we come to the frequency modulated instrument, and the audio generator, in the next part of this series, and later, when the oscilloscope and its applications are considered.

TV Alignment

Alignment of television receivers, which is an extension of the foregoing notes, is dealt with more completely in a self-contained article which will appear in the May issue of our companion journal, *Practical Television.*

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* Footnote: *Where an image rejector is fitted, this will normally be adjusted for minimum response at a frequency of twice the intermediate frequency from a strong local station. (For example, for a receiver with 465kc/s i.f., inject a strong 247m, 1215kc/s signal and tune the set to 1056m, 284kc/s, adjusting for minimum output.)*

If the local oscillator circuits are interdependent, it may be necessary to align the medium wave first.

PART 5 OF THIS SERIES APPEARS NEXT MONTH

FITTING AN EARPHONE

Many transistor portable radio sets are not provided with a socket for an earphone. Here is a simple method of adding this facility.

by K. Royal

ALTHOUGH the majority of currently manufactured transistor receivers feature an earphone socket, many of the earlier models, of which many thousands are in active use, have no such refinement. As there are often occasions when it is desirable to employ a transistor portable as a "personal" receiver, we are sure that many readers will be interested to discover the best way of connecting an earphone to a transistor set which was not designed originally for such an addition.

REQUIREMENTS

There are four essential requirements related to the exercise: one, there should be adequate earphone volume; two, the action of plugging-in the earphone jack plug should automatically switch off the loudspeaker; three, the earphone circuit should not disturb the normal operating conditions of the transistors; and four, earphone operation should considerably reduce the drain on the batteries.

The first three of these requirements could be met by connecting an earphone jack socket in the loudspeaker circuit so that when the jack plug is inserted the loudspeaker is disconnected and its place taken by the earphone loaded with a resistor of suitable value to maintain correct matching in the collector circuit of the output transistors.

The earphone then, in effect, would act so far as the circuit is concerned exactly like the loudspeaker. There would be more than adequate volume, and the battery power consumption would be related to the volume level used, as it is on all transistor sets employing a Class B output stage. Thus, as only a small volume level would normally be used on the earphone, the consumption should be somewhat less than what it would be with the loudspeaker connected. Unfortunately, this is not strictly true, since quite a lot of power is dissipated across the load-matching resistor, in parallel with the earphone.

Another idea which is sometimes adopted by experimenters is to arrange the jack plug/socket action to connect the earphone to the collector circuit of the driver transistor while at the same time removing the loudspeaker and in its place connecting an equivalent value load resistor.

This set-up is highly inefficient, for to secure sufficient earphone volume it is necessary to have a fairly high setting of the volume control and, even though the push-pull output transistors are disconnected from the loudspeaker, audio power is still being dissipated across the resistive load and the battery drain is comparable—if not greater—than when the loudspeaker is used. In other words, power is being thrown away unnecessarily.

OUTPUT MUTING

By far the best idea is to arrange for the output transistors and associated circuit to be muted as a whole when the earphone is plugged in. This will leave the driver stage fully operational, and from

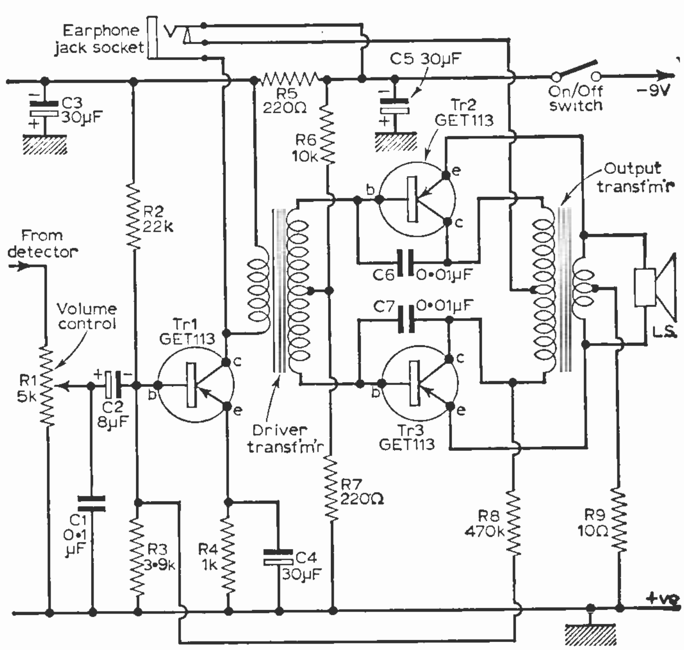

Fig. 1: The driver and output stages of a typical transistor receiver.

this the small amount of power to provide adequate earphone volume can readily be obtained.

Fig. 1 shows the driver and output stages of a typical transistor receiver. Here Tr1 is the audio driver transistor, while Tr2 and Tr3 are the push-pull output pair set-up in Class B mode. Signal from the detector diode is fed to the volume control, from whence audio of the required level is tapped and fed to the base of Tr1. The collector of this transistor is loaded in the usual manner with the primary of the driver transformer.

Audio signal is induced into the centre-tapped secondary and the bases of Tr2 and Tr3 are fed in the conventional anti-phase manner from this winding. The collectors of Tr2 and Tr3 are applied across the primary of the output transformer, and are energised battery-wise from the centre-tap. The secondary of the transformer is connected across the loudspeaker speech coil.

REFINEMENTS

The circuit shown features various refinements from the negative feedback aspect, but in the main is typical of many sets; and in any case, the principle as described will not differ substantially.

It will be seen that the earphone jack is of the type which has short-circuit contacts when the jack plug is removed, which open circuit when the plug is inserted. Such jack plugs and sockets are readily available in miniature form from most radio dealers.

The signal contacts of the jack socket are connected between the collector of the driver transistor Tr1 and the battery negative line, while the short-circuiting contact is connected to the centre tap of the primary of the output transformer.

Now, in the position illustrated, with the jack plug removed from the jack socket, the receiver functions in the ordinary manner, for there is no earphone load across the driver transistor collector and battery voltage is still being applied to the primary of the output transformer through the short-circuit contacts in the jack socket.

JACK SWITCHING

However, when the jack plug is inserted the earphone is connected between the collector of Tr1 and the battery circuit, and good quality, loud sound will be heard in the earphone, controllable in the ordinary way by the volume control. At the same time the hitherto shorting contacts will open and remove voltage from the tap on the primary of the output transformer, thereby quelling collector voltage on the output transistors. This action will, of course, remove the major power-consuming circuit from the batteries while obviously killing the loudspeaker circuit.

The power consumption thus drops from about 25-30mA at average loudspeaker listening level to about 5mA at all levels on the earphone—a power saving that is well worthwhile.

The earphone should be of the high or average impedance type, quite a range of which is available on the surplus and other markets. ■

Simple BFO Unit

BY S. G. WOOD

FACED with the necessity of converting an ordinary broadcast receiver for the reception of c.w. the following small unit was constructed. Built around a small triode of the 6J5 or 6C5 class, very few components are required.

The circuitry—as Fig. 1 shows—is quite orthodox. and the items needed are all standard. An i.f. transformer removed from an old broadcast set with a range around 465kc/s was used in the author's unit, but any similar i.f. transformer would suffice, provided it is of suitable inductance.

The other components comprise a fixed capacitor of 100pF and another of 0·001μF, a couple of ½W resistors of 47kΩ and 10kΩ respectively. A standard octal valveholder and a small panel mounting on/off switch complete the list.

There is nothing at all critical about the general lay-out of the b.f.o., and the entire unit may well be tucked away in any odd corner of the main receiver chassis, as space permits. Assuming the builder to have at least some experience of radio construction, it is not proposed to give too explicit details. However, the usual care should be taken as regards insulation of all H.T. points, and good strong soldered joints are, of course, essential.

If on "testing out" the unit, difficulty is experienced in obtaining a strong "beat note", then a short length of insulated wire may be connected from the anode circuit of the oscillator (as shown), with its "free" end wrapped round the detector lead a few turns to provide capacitative coupling. Ensure that no bare wire is allowed to make contact.

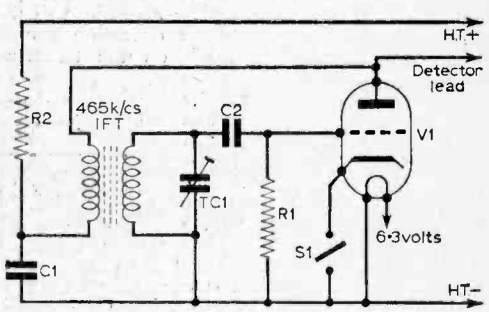

Fig. 1: The circuit of the unit.

The above "pick-up" wire will not always be necessary and sufficient r.f. "pick-up" may find its way through the normal power supply channels.

Should it be desired to vary the pitch of the beat note, then a small trimmer of around 40 or 50pF could be wired across the secondary of the i.f. transformer on the b.f.o.—this is a worthwhile "refinement" but is not essential!

In conclusion it may be mentioned that the writer has been using this particular arrangement in conjunction with an old type b.c. receiver and 160m converter for several months with most satisfactory results. ■

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SCHEDULE OF LOUDSPEAKERS AVAILABLE

Diameter in inches	*Gauss in lines*	*Imped. in ohms*	*Price*
2	7000	80	8/-
2½	7000	35	8/6
2½	7000	50	8/6
2½	7000	80	8/-
3	7500	5	8/6
3	8500	3	8/6
3	8500	5	8/6
3	8500	10	8/6
3½	7000	35	8/6
4	5000	3	7/6
4	6000	3	8/-
4	7000	3	8/6
4	9500	3	9/6
4	9500	5	9/6
4	10000	3	10/-
4	6000	25	10/6

Diameter in inches	*Gauss in lines*	*Imped. in ohms*	*Price*
4	7000	25	11/6
4	6000	35	10/6
4	7000	35	11/-
4	9300	35	11/6
4	9500	35	11/6
4 tweeter	6000	3	7/6
4 ,,	7000	3	8/-
4 ,,	7000	5	8/-
4 ,,	8500	3	8/6
4 ,,	8500	5	8/6
4 ,,	9500	3	9/6
5	6000	3	8/-
5	7000	3	8/6
5	7000	5	8/6
5	7500	3	9/-
5	8500	3	9/6

Diameter in inches	*Gauss in lines*	*Imped. in ohms*	*Price*
5	8500	5	9/6
5	9500	3	10/6
5	9500	5	10/6
5	10000	3	11/6
5	12000	3	12/6
5	6000	25	10/6
5	6000	30	10/6
5	6000	40	10/6
5	9500	25	11/6
5	9500	30	11/6
5	9500	35	11/6
5	6000	60	10/6
5	9500	50	11/6
5	10000	25	12/-
5	10000	35	12/-
6½	6000	3	10/6

Diameter in inches	*Gauss in lines*	*Imped. in ohms*	*Price*
6½	7000	3	11/-
6½	7000	5	11/-
6½	8500	3	11/6
6½	9500	3	12/-
6½	10000	3	12/6
6½	12000	3	13/-
8	6000	3	11/6
8	7000	3	12/-
8	7000	5	12/-
8	8500	3	12/6
8	8500	5	12/6
8	10000	3	13/6
8	10000	5	13/6
8	10000	8	13/6
8	12000	3	14/6
8	12000	8	14/6

Elliptical Size	*Gauss in lines*	*Imped. in ohms*	*Price*
5×3	6000	3	7/6
5×3	7000	3	8/-
5×3	7000	5	8/-
5×3	9000	3	8/6
5×3	9000	4	8/6
5×3	9000	5	8/6
5×3	6000	25	9/6
5×3	7000	25	10/-
5×3	7000	35	10/-
5×3	9000	25	11/-
5×3	9000	35	11/-
6×4	6000	3	8/6
6×4	7000	3	9/-
6×4	8500	3	9/6
6×4	9500	3	10/-

Elliptical Size	*Gauss in lines*	*Imped. in ohms*	*Price*
6×4	9500	5	10/-
6×4	12000	3	11/-
7×3½	6000	3	9/6
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7×4	7000	3	10/-
7×4	7000	4	10/-
7×4	7000	5	10/-
7×4	8500	3	10/6
7×4	9500	3	11/-
7×4	9500	4	11/-
7×4	9500	5	11/-
7×4	9500	30	11/6
7×4	9500	35	11/6

Elliptical Size	*Gauss in lines*	*Imped. in ohms*	*Price*
7×4	9500	50	11/6
7×4	10000	3	12/-
7×4	10000	5	12/-
7×4	10000	15	12/6
7×4	12000	3	13/-
7×4	9500	3*	13/6
8×2¾	6000	3	8/6
8×2¾	7000	3	9/-
8×2¾	7000	5	9/-
8×2¾	6000	6	8/6
8×2¾	6000	30	9/6
8×2¾	8500	5	9/6
8×2¾	9500	3	10/-
8×2¾	9500	4	10/-
8×2¾	9500	5	10/-

Elliptical Size	*Gauss in lines*	*Imped. in ohms*	*Price*
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8×2¾	9500	50	10/6
8×2¾	10000	3	10/6
8×2¾	10000	5	10/6
8×5	6000	3	8/6
8×5	7000	3	9/-
8×5	8500	3	9/6
8×5	8500	5	9/6
8×5	8500	35	12/6
8×5	9500	3	10/-
8×5	9500	15	13/6
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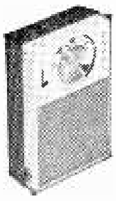

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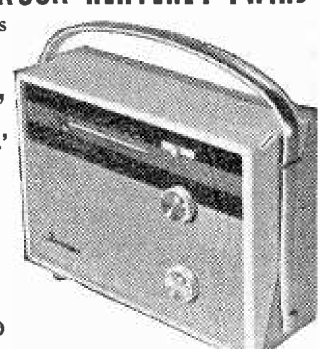

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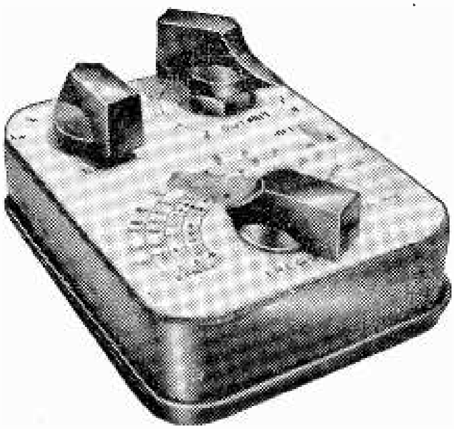


MINIATURE TEST OSCILLATOR

by R. Leyland

VERY compact pieces of equipment are nowadays made possible by using miniature components. These concentrate the required circuit constants into a limited space without the loss of efficiency by incorporating low-loss cores and dielectrics. The construction of an r.f. oscillator with a frequency coverage of from 160kc/s to 10Mc/s in four switched bands is therefore practicable with dimensions as small as 5in. x 3in. x 1⅛in.

SCREENING

The Miniature Oscillator is similar in power to the oscillating frequency-changer of an average transistor radio (which is only partially screened) so screening is required more to enable the output to be controlled rather than to avoid interference. Even a double-screened oscillator has a small external field, so it is a question of attenuation rather than of complete elimination.

Reducing the space occupied by an oscillator circuit decreases its radiation, and as the transistor oscillator does not need ventilation or an external power supply, screening is less of a problem and filters in supply leads are not necessary.

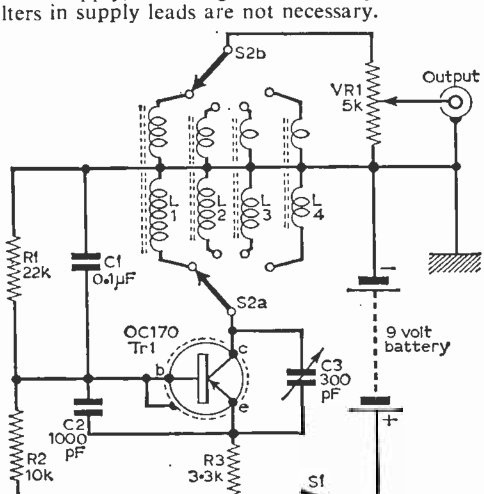


Fig. 1: Circuit diagram of the oscillator.

The residual field of this oscillator, although distinctly perceptible, is not troublesome, and the output comes, as it should, almost entirely through the output socket. To reduce this residual field still further, an extra screen was fitted internally around the coil turret and earthed at the output socket.

Tinplate boxes are not only easy to obtain, but are more effective against the stray magnetic induction field of the oscillator than non-ferrous metal of the same thickness. The case of the oscillator was made from a box of first-aid dressings, the sides being increased in height by soldering double strips of tinplate around them.

This can be done quite neatly using two strips meeting in the middle of the two shorter sides. The other dimensions of the box are preserved so that the lid continues to be a good fit. The soldered joint is not noticeable when the oscillator case is painted.

Single-point earthing is a sound principle for the avoidance of chassis loops and the earthing point should be at the output socket. However, the use of the earthing tag at the side of the output potentiometer, linked by a short connection to the main earthing tag, is convenient and has very little effect upon the r.f. leakage.

In this particular oscillator, the projecting shaft of the tuning capacitor is not earthed to the case and is at a small r.f. potential relative to the case. Thus it may be expected to radiate slightly, but the radiation is negligible, which is fortunate as there would not be room for an insulated shaft coupler.

What residual field exists is probably due to the thin gauge of the tinplate box. However, the presence of an induction field does not imply widespread radiation, for the induction field, in contrast with the radio wave, decreases rapidly with distance from the oscillator.

The considerable difference made by the screening can be observed by noting the increase of radiation when the lid is removed. Removing the lid slightly increases coil inductance, so the oscillator requires to be retuned to the same frequency to (apparently) a slightly higher frequency on the tuning dial.

OSCILLATOR CIRCUIT

Choice of the type of oscillator was guided mainly by experiment. This form of oscillator (Fig. 1) appeared less affected than some others by changes in battery voltage, and gave no trouble from squegging. It is about as simple an arrangement as could be devised and reliable enough for general testing purposes. The current drawn from the battery is small and after a small initial frequency drift of a few minutes after switching on, the frequency remains steady for a considerable period. A valve oscillator, unless well ventilated, can drift for much longer during the warming-up period.

A minor aberration that has not been accounted for, and does not appear to be due to looseness of the knob on the shaft. is that the position of a given frequency is slightly higher on the scale when approached from below.

It was convenient to earth the negative line (collector supply for a p-n-p transistor) to the case, and as the base of the transistor is connected to the negative line via a 0·1μF capacitor C1 the circuit can be described as "grounded-base".

The emitter is therefore the driven electrode, with its waveform in phase with that of the collector, and is fed from a capacitive tapping on the tuned circuit which comprises L in parallel with C1, C2, C3 in series. Of these, C1 acts as a short circuit at r.f., leaving the smaller values C2, C3, in series, as the effective tuning capacitance.

The miniature tuning capacitor, C3, is a solid dielectric capacitor of low-loss construction. Its maximum value of 300pF is reduced by C2 (1,000pF) in series with it to 231pF, giving a maximum (including stray capacitance) of 254pF. Its minimum capacitance is 7pF, but strays in the rest of the circuit increase this to 30pF, so the capacitance ratio is 8.4:1 and the frequency coverage of each range (the square root of the capacitance ratio) is approximately 2·9:1.

A wider tuning range on each band could be obtained by using the 500pF version of this capacitor. This has a minimum capacitance of 9pF, so the minimum circuit capacitance would be 33pF and the maximum (in circuit) 365pF, yielding a tuning ratio of about 3·3:1 or 14% more.

Ideally, separate capacitance trimmers on each band should be incorporated to equalise the minimum capacitances and make the scale shape the

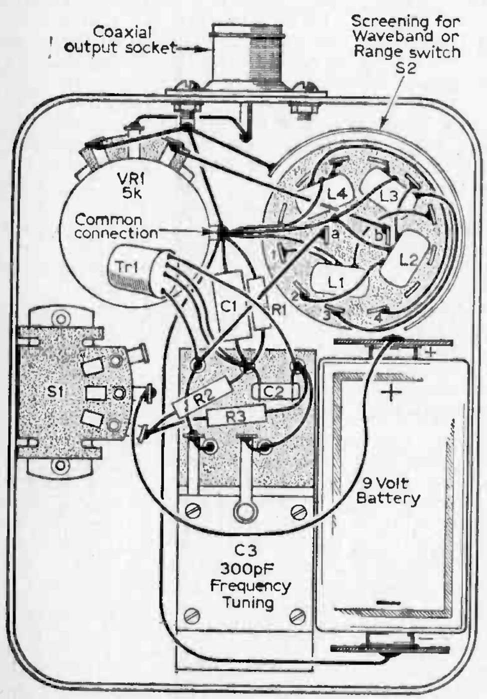


Fig. 2: Interior view showing layout and wiring.

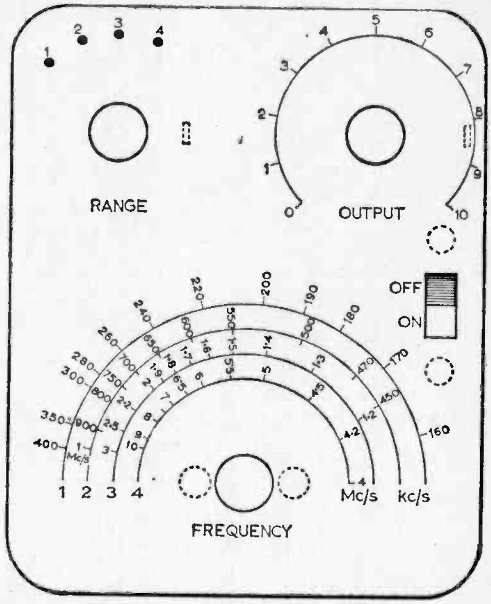


Fig. 3: Oscillator scale plate. This is made up from 18s.w.g. aluminium covered with drawing paper.

same on each band. There is room on the connector board for one miniature ceramic trimmer, but it seemed necessary to avoid increasing the minimum capacitance as it would further restrict the tuning range, so this trimmer was omitted.

It might seem that C2 should be variable as well as C3, but a fixed value of 1,000pF serves quite well. This value gives a sufficiently uniform performance and does not reduce the maximum frequency of oscillation as the higher value would.

ADDITIONAL RANGES

The wavechange switch only accommodates four toroidal coils, but in any case it was found that further ranges would only have been possible by making circuit modifications. For example, at lower frequencies the collector would have to be tapped down the coil to match it to the high circuit impedance. Otherwise oscillation stops at high L/C ratio, i.e., towards minimum capacitance on the tuning range.

Tapping the collector down the tuned circuit is also desirable to reduce the effect of the transistor on the oscillator frequency and waveform, but it requires more complicated coils and switching arrangements and is not applicable on the highest frequency range where the impedance of the tuned circuit is lower.

At still higher frequencies, phase shift inside the transistor appears to dictate another modified circuit arrangement, and this again cannot be included without undesirable complexity of switching, but the transistor used did not have a particularly high cut-off frequency. and a higher range might have been possible with a suitable transistor.

The stabilising arrangement is of the orthodox form employing a potential divider, R1 and R2, to set the base voltage to about a third of the battery voltage. The emitter voltage is only slightly less and the emitter resistor, R3 sets the emitter current accordingly to a value of about 1mA.

Oscillation increases and decreases the transistor current to some extent on the different ranges, but even in the absence of oscillation, the collector current would remain stabilised, which is an advantage with transistors that might have an exceptionally large leakage current, or if oscillation should stop at a low capacitance setting.

The oscillator is unmodulated and would have to be used mainly with visual indication, i.e. a meter reading the d.c. output of the detector of a receiver. An external modulating unit could, however, be connected if required. There is also the possibility of including a modulating circuit in the vacant corner of the oscillator.

OUTPUT

The coupling coils are wound to give an output of about 200mV r.m.s. on each range, but on range 4, the output is slightly higher. A potentiometer VR1 is included to enable the output to be adjusted when connected to a resistive load, which can be as low as 200Ω, but preferably higher to reduce the shift of oscillator frequency. The scale divisions 0-10 are arbitrary and facilitate setting of the output control. They do not represent values of output. The potentiometer only gives a small range of control, and if necessary can be supplemented by plugging an external attenuator into the output socket.

Output varies over the tuning range to some extent, but is nearly constant on one half-cycle. This is due to the limiting action of the transistor on positive-going half-cycles at the collector when the collector-emitter voltage approaches zero.

A certain amount of waveform distortion is inevitable in the absence of any other form of amplitude control, and is not easily reduced while maintaining oscillation over the entire range. Waveform distortion is equivalent to the presence of harmonics, which have their uses in calibrating the oscillator, etc.

A high Q-value in the tuned circuit reduces the amplitude of harmonics relative to the fundamental, and the flattening of alternate peaks is more marked in the waveform at the emitter than at the collector. It also appears to be less on the higher ranges, where harmonics are probably more

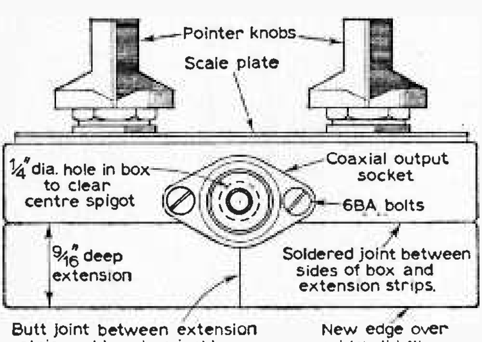


Fig. 4: End view of the oscillator.

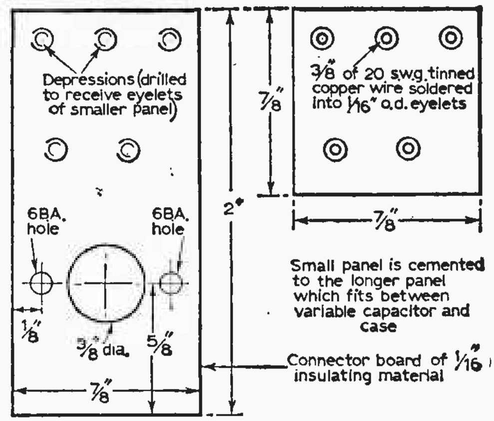


Fig. 5: Connector board, made up of $\frac{1}{16}$ in. insulating material.

heavily attenuated. Harmonics on range 4 are not strong enough to produce TV interference even without screening.

In measuring the output on the lower ranges, it would be necessary to filter out the harmonics to obtain the actual amplitude of the fundamental.

MINIATURE COIL TURRET

The coil turret with its four ranges is probably as small as can be made with available components, and its construction requires a certain amount of skill in winding the coil for range 1, and also in attaching leads to the coil.

A cylindrical screen completely enclosing the coil turret would probably reduce r.f. leakage to minute proportions, but owing to the close proximity of the battery, it was only possible to partly surround the switch and coils by an internal screen.

However, it is doubtful whether the most painstaking precautions against r.f. leakage are worthwhile in a small test oscillator, and the existing internal screen could be omitted if preferred. It consists of a curved 2½in. x 1in. strip of tinplate, carefully insulated with plastic insulating tape to avoid short-circuits.

The miniature wavechange switch is 2-pole 6-way but only four of the six positions are used. Originally it was intended to include more ranges. If a 3-pole 4-way switch is used, the wiring will be somewhat different. In the 6-way switch, the contacts for each coil are diametrically opposite.

THE COILS

In a miniature oscillator, the coils should be of types that achieve the maximum inductances in a limited space, and should also have a low external field so that they can be placed inside a screening box with little loss of efficiency or change of inductance. Also their close proximity in a coil turret must not result in absorption trouble from self-resonance of coils not in circuit. Although the coils in this oscillator have not been screened from each other, capacitive coupling between them is too small for absorption effects to occur from this cause.

Pot cores or toroids could be used, but the latter are smaller and have a more efficient magnetic circuit. They are not, however, suitable where the highest stability is required because, lacking an air gap, they have a larger variation with temperature and d.c. magnetisation.

The toroidal cores used were actually ferrite cups of the type used in miniature i.f. transformers, and can be obtained from a miniature pot core assembly such as Neosid Type 1. The inductance for a given number of turns is about 1½ times as large as for the miniature pot core, notwithstanding the smaller amount of ferrite material. This makes it possible to obtain a fairly high Q-value with random winding using single strand conductors.

A disadvantage of toroids in some applications is that their inductance cannot be adjusted by screwing a core in and out, but in a variable-frequency oscillator it is quite satisfactory to set the inductance to a fixed value by initially adjusting the number of turns.

Winding the miniature toroids is easy up to about 90 turns, but the 270 turn coil obviously calls for a special technique. A two-part core would be one solution, but breaking the core and

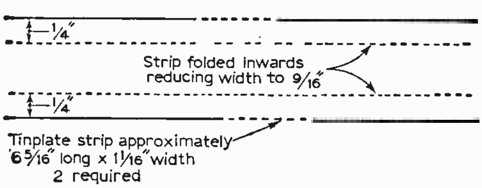


Fig. 6: Extension for sides of box.

cementing it together after winding would be somewhat risky. The method actually used was to wind a hank of 6yd of 42s.w.g. d.s.c. wire on a 3in. diameter tube, and then to wax it into a bundle narrow enough to pass through the core. About a yard is unwound at a time by remelting the wax with a barrel of a soldering iron. Each ten turns is noted by entering a mark in a column on a sheet of paper. Any tangles or kinks that occur must be carefully undone. The main coil and coupling coil are wound on opposite sides of the ferrite ring, at the semi-circular notches.

The formula for the inductance of the miniature toroids was found to be: $L=0{\cdot}06\ N^2\ \mu H$.

Thus with $N=270$ turns. the inductance is 4.4mH. The actual coil in the oscillator has 265 turns.) With 90 turns the inductance is $490\mu H$.

For the 90 turn coil, 61in. of 42s.w.g. d.s.c. wire should suffice: and for the 30 turn coil 22in. of 38s.w.g. The 10 turn coil is of 26s.w.g. but here the inductance is lower than given by the formula, probably because instead of being pile-wound, the turns have been spread out in a single layer.

Leads of thicker wire (26s.w.g.) have to be attached to L2, L3 and L4 to anchor the coils in position. The soldered joints are insulated with folded squares of ½in. plastic insulating tape. Each lead should be sleeved with a characteristic colour to avoid confusion. One lead is common to both coils.

The three insulated joins of each coil are laid axially across the outside of the ring cores, and a strip of the plastic insulating tape is wound firmly

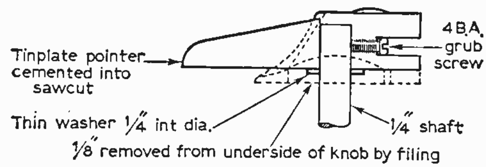


Fig. 7: Section through modified pointer knob.

round the circumference and the overlap on each side pressed in towards the centre. Then a ½in. square of the plastic tape is applied on both sides to seal the coil completely in a plastic jacket.

There are more professional ways of encasing the coils, by dipping or moulding them in polyester resin, but for just a few coils this trouble seemed unnecessary.

The common lead of each coil goes to the earthing point, while the other two leads go to the appropriate switch tags which in a 2-pole, 6-way switch are radially opposite each other.

CONNECTIONS

The connecting points for the transistor and associated resistors and capacitors are on a small panel of $\frac{1}{16}$in. insulating material cemented to a longer strip which is fastened to the case by the tuning capacitor.

The tags are made of pieces of 20s.w.g. copper wire soldered into small eyelets in the $\frac{1}{16}$in. insulating material, and provide a very satisfactory and simple means of anchoring components. The introduction of this connector board may increase dielectric losses at minimum capacitance, but probably very little.

Soldering should be carried out rapidly and the transistor leads gripped with radio pliers until the joint cools to keep heat from reaching the transistor. The leads should not be cut and are shortened only to the extent that they encircle the tags. The two outer leads are sleeved.

Transistors of the four-lead type such as OC170 and OC171 have one lead in electrical connection to the metal cylinder of the tranistor. This lead can be connected to the base in the grounded-base circuit, the two centre leads being wired to the same tag. The case of the transistor can then be insulated with transparent adhesive tape to avoid a possible short-circuit through contact with some other part of the oscillator.

The incorporation of a five-pin holder for the transistor would, in addition to safeguarding the transistor during soldering, offer a means of testing other transistors and finding their maximum

Details of Coils

Range	Frequency coverage	Number of turns: Tuning coil	Number of turns: Coupling coil	S.W.G.
1	160-400kc/s	L1, 270	24	42
2	450kc-1Mc/s	L2, 90	9	42
3	1·2-3Mc/s	L3, 30	4	38
4	4-10Mc/s	L4, 10	2	26

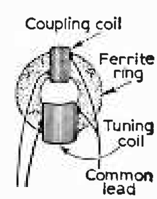


Fig. 8: Details of coils.

frequency of oscillation. The three centre connections of the five-pin holder, connected together would serve as terminals for base and screen leads.

Special care should be taken with the three miniature resistors. The body of the resistor should not be held when forming the leads, nor should one lead be held when bending the other. It is best to hold one lead near the resistor with small pliers while forming that lead to the required shape.

A small on/off switch was fitted towards the side of the oscillator. This is of the 1-pole 2-way type with one contact left unused. The miniature potentiometer could be obtained combined with on/off switch if preferred. This would make it possible to transfer the battery to the other side where it would have slightly more room in the lengthwise direction. The on/off markings would then, of course, require to be transferred to the zero portion of the potentiometer dial.

The 9V battery (type PP4 or DT4) fits into the space on one side of the tuning capacitor. Owing to the lack of room, the large tags had to be broken off the battery connectors to avoid the risk of short-circuits, and as a further precaution, the exposed surfaces of metal of the connectors were insulated with plastic insulating tape after soldering leads to them.

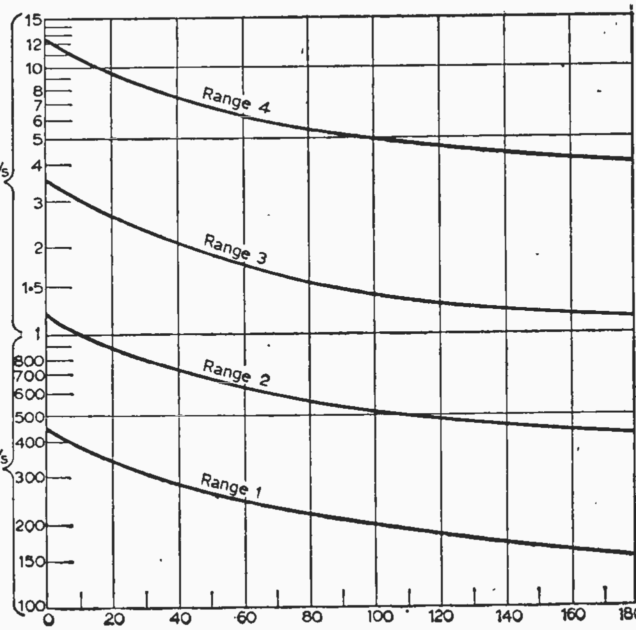


Fig. 9: Calibration chart for oscillator.

CALIBRATION

It is convenient to fit a removable scale made of 18s.w.g. or thinner aluminium. Drawing paper can be fixed to this with adhesive. After marking on the scales with indian ink, a clear adhesive can be applied to the surface forming a protective plastic coating.

The shaft of the tuning capacitor projects only about $\frac{5}{16}$in, after passing through the combined thickness of connector panel, box, and scale plate, and the only solution seemed to be to file $\frac{1}{8}$in. off the underside of the knob. This was done in a vice with some folded paper wadding to avoid damage. A further need was for the pointer to sweep four scales at once, and so a slit was sawn in the front of the knob and a strip of metal cemented into it to serve as a pointer of the anti-parallax type. Clear plastic knobs combining some form of cursor line seem only to be available in larger sizes and mainly in construction kits for radio sets.

To ensure a positive grip on the shaft, the up-to-date method of having a flat portion on the shaft with the end-screw fixing would have been preferable, because looseness of the knob on the shaft is liable to produce errors both in calibration and in using the oscillator. But there is the associated problem of finding a suitable pointer knob.

The ideal method if calibration is by means of a crystal calibrator, using harmonics of a 100k/cs and a 1Mc/s crystal. The alternative is a calibration to be carried out. The alternative is a more random method using the frequencies of known radio stations as standards. With this, discrepancies are more likely to creep in.

Range 1 is easiest to calibrate because its harmonics give numerous whistles on medium wave stations. It is only necessary to attach a few inches of insulated wire to a plug fitted into the coaxial output socket and to bring the oscillator close to a radio receiver. For weak harmonics it may be necessary to entwine this wire with the aerial wire of the receiver to increase the coupling.

Taking three known medium wave stations, "A", "B" and "C", one can mark all the positions where harmonics of the oscillator coincide with the one of these stations to give whistles (actually the whistle drops in pitch and becomes inaudibly subsonic at exact coincidence of frequency).

Dividing the frequency of each station by 1, 2, 3, 4 . . . in turn, the order of successive whistles can be tabulated as in the example below.

By comparing the sequence of whistles on the radio stations, and especially by noting any near coincidences (for two stations) that occur—there

—continued on page 52

A	f_A			$f_A/2$	$f_A/3$		$f_A/4$		$f_A/5$		$f_A/7$		$f_A/8$
B		f_B			$f_B/2$			$f_B/3$				$f_B/5$	
C			f_C			$f_C/2$				$f_C/3$		$f_C/4$	

By A. Cole

Quality Amplifier and tuner

Continued from page 1107 of the April issue

COMPLETING THE TUNER AND INSTALLING THE UNITS IN THE CABINET

THE proper degree of a.f.c. is that which just still allows automatic re-capture after momentary removal of the aerial for all settings of the range of lock-in of a station. If this cannot be achieved then the a.f.c. is excessive, and must be reduced by turning VR2 slider closer to V8 anode.

If, on the other hand, tuning is virtually impossible, every station slipping away again before it is properly tuned in, then the polarity of the a.f.c. is incorrect. The connections between pins 7, 5 of V6 and the relevant tags on f.m./IFT5 should simply be exchanged to effect a cure.

Note that the specified value of C56 should be strictly adhered to, as this capacitor sets the time-constant of the a.f.c. Too small a value would allow hum and audio to frequency modulate the local oscillator; too high a value could cause the circuit to hunt, leading to strong motor-boating.

V.H.F. Alignment

Only a conventional signal generator and an ordinary multimeter of about 1,000Ω/V are required. Connect the multimeter (25 or 50V d.c. range across C43. Radiate from the dummy aerial of the signal generator, set accurately to 10·7Mc/s, close into the wiring around the i.f. stage furthest from the ratio-detector which still gives a visible meter deflection.

Peak the slugs of all f.m. i.f.t.'s *except* the diode winding of IFT5 (bottom slug). Adjust the other slugs starting from V5 anode and working backwards. If at any stage the circuit bursts into oscillation (*sudden* high meter-reading), reduce the value of the damping resistor across the winding whose slug was adjusted just before oscillation commenced. The final *percentage* reduction should be twice that just sufficient to remove oscillation.

If no damping resistor is shown for the winding in question use 4·7kΩ. However, the damping arrangements shown in Fig. 9 should be sufficient to prevent the i.f. amplifier going into oscillation.

Reduce the signal generator output as the peaking proceeds, and take the point of injection right back to a couple of loops of wire round the ECC85 in the r.f. head as soon as possible. Keep the meter reading below 5V at all times. to avoid limiter action. When the amplifier is peaked-up. including the top and bottom i.f. slugs on the r.f. head, turn up the signal-generator output until limiter action sets in at V5, V6, i.e. no further increase of output. The limited maximum rectified output across C43 should read about 15V.

Remove the meter from C43, and connect across the track of VR2, using the 50V d.c. range. Tune the r.f. head right off all stations, and note the meter reading exactly. Now feed in an i.f. signal at 10·7Mc/s, again by means of a loop round the ECC85 V1. The meter reading may rise or fall; adjust the diode coil of IFT5 (bottom slug) until the original reading is restored *exactly*. This should be about 20V.

Check that detuning the signal-generator slightly either side causes the meter reading to rise or fall, respectively, by about 4V, before returning to the original centre reading with further detuning. The f.m. alignment is then complete.

Ignoring the switching for the present, the arrangement for the medium and long wave stations is seen to be a more or less conventional superhet comprising a triode-hexode frequency changer, pentode i.f. amplifier and double-diode-triode functioning as detector, a.v.c. diode and a.f. amplifier. The only significant basic addition not present in most domestic superhets is the high-gain tuned r.f. stage.

Screening in the R.F. Stage

To ensure stability in the r.f. stage a brass-foil screen is inserted between the front and rear two wafers of S1. This foil is clamped between the bushes on the switch assembly bolts and has in its centre the smallest possible hole drilled to allow clearance of the spindle without scraping. The foil is earthed to chassis through a wire going to a soldering-tag near the switch.

Wires from the switch wafers go in a bunch through a grommet close by, to the r.f. grid coils on the other side of the chassis.

L5 to L8 are the r.f. anode coils and associated hexode grid coupling coils.

Note the convenient layout in relation to the two i.f. transformers, FM/IFT1 and 2, required when V2 serves as first i.f. amplifier on f.m. Also, the arrangement in relation to S2 (a.m./f.m. switch) for shorting-out the aerial coils on f.m.

The constructor is advised not to make any drastic departures from the component arrangement shown in Figs. 2, 3. The flying junctions of components should not be taken to extra soldering tags, as leads could become too long.

An aluminium screen about three-quarters the chassis depth in height is bolted to the centre of the chassis. This screen prevents interaction of the four stages through feedback on f.m., when all four operate at the same frequency of 10·7Mc/s. Feedback through the switch leads on S2 is then avoided by the fact that these switch leads are all at r.f.-*earth* potential on f.m. On a.m. they are no longer all at earth, but then V2 and V4 operate at different frequencies, while V5 is disconnected from the h.t. supply, so that instability is not possible.

Note that S2e switches h.t. *either* to the a.m. local oscillator *or* to the v.h.f. limiter stage. S2a improves the efficiency of V2 as an i.f. amplifier, and keeps the 10·7Mc/s signals out of the a.m. tuner coil banks and switching. Furthermore, in shorting-out the a.m. aerial circuits, it prevents spurious injections of direct 10·7Mc/s signals from the a.m. aerial.

S2d shorts out the second a.m. IFT primary, to prevent 10·7Mc/s i.f. signals reaching the a.m. detector on f.m. operation. S2c and S2f remove a.v.c. on f.m. function, to give maximum gain, and thus powerful limiter-saturation. On a.m., however, powerful delayed a.v.c is applied to three stages, which levels out highly-fluctuating signals.

Coil Modification

In case of oscillator failure on the Luxemburg channel, the simplest and quickest cure will be to strip off all existing windings from the QO8 m.w. oscillator coil and wind on enamelled-copper wire windings, using 0·3mm diameter wire. First 58 turns, pile-wound, as oscillator grid coil. Then a layer of P.V.C. tape, and on top a neat layer of 20 turns close-wound (same wire) as anode coil. The senses of the two windings should be the

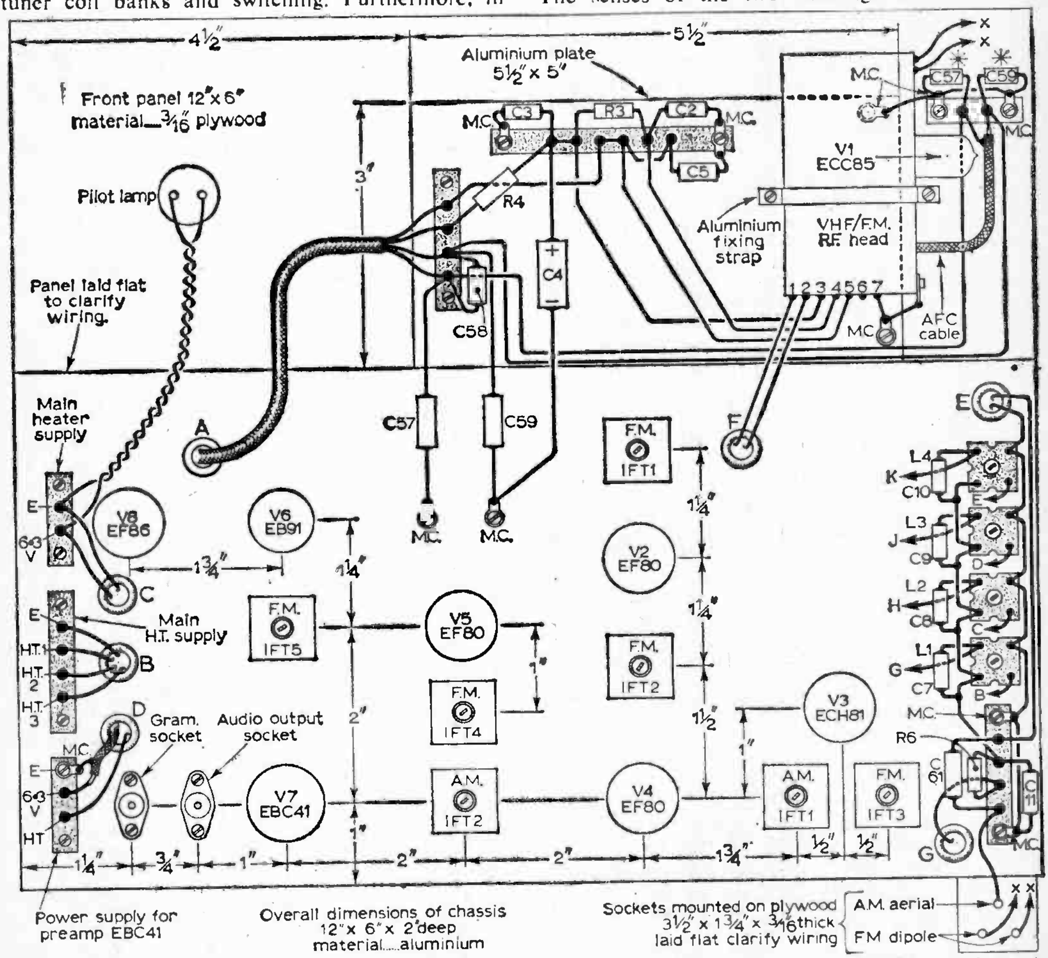


*Fig. 12: The above-chassis and panel layout and wiring diagram. Dimensions are also shown. *C57 and C59 may be connected at either or both positions indicated.*

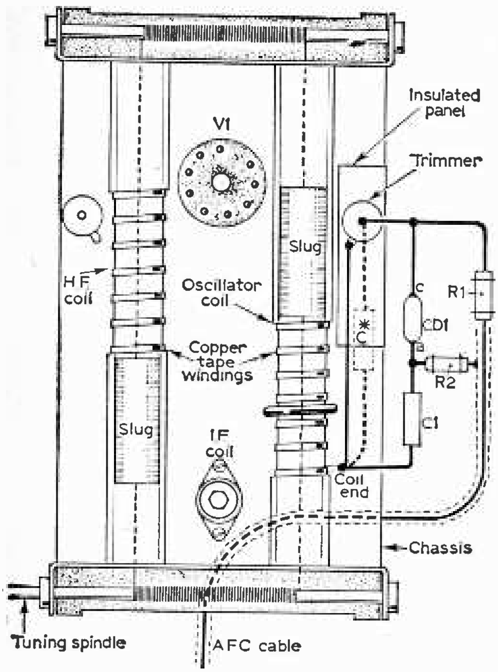


Fig. 13: The connections of the a.f.c.-components on the f.m.-head.

The h.t. and heater feeds for V7 triode here must be taken from the amplifier/power pack chassis as follows: h.t. from the junction C2/D1; l.t. from the 6·3V 2A winding on T1. In other words, V7 must still receive supplies when the rest of the tuner is switched off for pick-up gramophone function, because this valve is still required as an audio pre-amplifier.

Type of Cabinet

No particular model is specified for the cabinet. The particular cabinet used consisted of a simple polished wood "box" on ornamental legs, divided into two sections of about equal volume by a removable horizontal wooden insert-board. This insert is used as mounting plate for the control panel, tuner chassis, record player mechanism and aluminium heat shield.

Suitable windows are cut out of the wooden plate for the electrical controls and the turntable mechanism. The amplifier control panel and tuner are then fixed to the back of the respective windows by means of wood screws. The amplifier and power pack unit is bolted in position on the cabinet base and joined through the firmly anchored bunch of cables to the control panel.

The tuner chassis hangs with the valves horizontal, and the amplifier power pack chassis is so positioned that it comes under the aluminium heat shield preventing scorching of the wood above due to heat from the output valves. This heat shield should be mounted with screws and stand-off washers or bushes so that it leaves an air gap between its upper side and the wooden plate, and bent such that it slopes gently upwards towards the back of the cabinet where the ventilation holes are situated. These measures are essential to prevent overheating of the complete assembly.

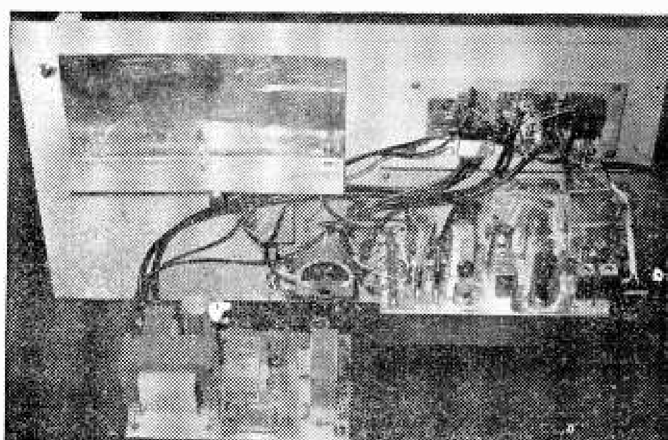
same as viewed from Tags 2 and 3 (see numbering of L12 in Fig. 1).

Such a rewound coil is used on the Luxemburg channel for L12 in the prototype, and the quoted value for C28 satisfies such a coil. Each channel has a separate set of three coils, using fixed parallel capacitors and preset tuning on the coil slugs. If other ranges are desired, the values of the fixed parallel capacitors can be modified.

Power Supplies

Three separate h.t. supplies of 200 to 300V, loadable to about 20 to 25mA each, are ideally required, and an additional low-power supply (about 1mA at 300V) for V7 triode. It is permissible to common all four h.t. supplies on to a power-pack of about 300V 60mA output. The heater requirements are about 3A at 6·3V.

The ideal power supplies are included on the chassis of the already published main amplifier specially designed for this radiogram combination. On Fig. 1 of that article (January 1963) the relevant h.t. outputs are to be seen. Note the remarks regarding the h.t. earth, heater earth and signal earth lines between the two chassis, made in the text of that article.



This illustration shows the tuner, control panel and record deck fitted to the mounting board and the amplifier connected by flying leads. Note also the aluminium heat shield.

Electrical Connections

Mains feed for the gram motor is taken from the soldering tags provided. The earth tag should be connected to the metalwork of the mechanism and to the amplifier heat shield. If the motor has only twin flex, a separate earth wire must be run.

Leads from the soldering tags marked "Earth-Bus" and "H.T. 1, 2 and 3" should be taken through a substantial 4-core flexible cable to the tags on the tuner marked "E, HT1, HT2, HT3" respectively. The two tags on the control panel labelled "Heaters" are connected to the corresponding "Main Heaters" tags (tuner wiring diagram). The lead coming from the switch wafers on the control panel is the one going to the main heater tag labelled "6·3V A.C." on the tuner wiring diagram.

The "Preamp EBC41" supply tags shown on the tuner above chassis wiring diagram are connected to the control panel by a three-core flexible power cable as follows: "E" and 6·3V A.C." across the pilot lamp on the control panel (observe correct polarity in relation to the main heater connections). The tag labelled "H.T." is connected through to the wiper labelled "h" on S2 on the control panel, ie.. to h.t.+1, ahead of S2.

A piece of coaxial cable is soldered with one end to the signal input terminal tags on the control panel and the other to a suitable coaxial plug for plugging into the "Main Amplifier" socket on the tuner chassis. The pick-up lead is also terminated by a coaxial plug for insertion into the Gram P.U. socket on the tuner chassis.

All this wiring may be done after the units have been fixed to the wooden plate.

COMPONENTS LIST

Resistors:

R1	56kΩ ⅛W	R26	47Ω
R2	56kΩ ⅛W	R27	68kΩ
R3	6·8kΩ 2W	R28	470kΩ
R4	2·2kΩ	R29	1kΩ
R5	5kΩ 5W w.w.	R30	1kΩ
R6	470kΩ	R31	6·8kΩ
R7	470kΩ	R32	6·8kΩ
R8	4·7kΩ	R33	470kΩ
R9	240Ω	R34	1MΩ
R10	47kΩ	R35	1MΩ
R11	1kΩ	R36	56kΩ
R12	4·7kΩ	R37	27kΩ
R13	47kΩ	R38	2·2kΩ
R14	4·7kΩ	R39	1MΩ
R15	220Ω	R40	470kΩ
R16	47kΩ	R41	270kΩ
R17	82kΩ	R42	56kΩ
R18	240Ω	R43	100kΩ
R19	47kΩ	R44	150kΩ
R20	4·7kΩ	R45	10kΩ
R21	4·7kΩ	R46	1kΩ
R22	47kΩ 2W	R47	68kΩ
R23	100kΩ	R48	68kΩ
R24	47kΩ	R49	4·7kΩ
R25	100kΩ	R50	4·7kΩ

All resistors ±10%, 1 watt, carbon, unless otherwise stated.

Capacitors:

C1	8pF C	C24	100pF C	C47	0·1μF P	C55	0·1μF P
C2	2500pF P	C25	100pF C	C48	830pF P	C56	50pF C
C3	2500pF P	C26	110pF C	C49	200pF C	C57	2500pF P
C4	16μF EH	C27	220pF C	C50	200pF C	C58	0·5μF P
C5	2500pF P	C28	100pF C	C51	25μF EL	C59	2500pF P
C6	8μF EH	C29	0·15μF P	C52	100pF C	C60	2500pF P
C7	330pF C	C30	0·015μF P	C53	0·15μF P	C61	0·01μF P
C8	200pF C	C31	0·05μF P	C54	8μF EH		
C9	350pF C	C32	0·05μF P				
C10	56pF C	C33	0·02μF P				
C11	0·1μF P	C34	8μF EH				
C12	0·1μF P	C35	See below				
C13	2000pF P	C36	50pF C				
C14	0·015μF P	C37	0·05μF P				
C15	0·01μF P	C38	2500pF P				
C16	0·05μF P	C39	2500pF P				
C17	330pF C	C40	300pF C				
C18	200pF C	C41	300pF C				
C19	350pF C	C42	300pF C				
C20	150pF C	C43	25μF EL				
C21	0·1μF P	C44	470pFC				
C22	2500pF P	C45	0·1μF P				
C23	0·015μF P	C46	2500pF P				

C=Ceramic, 500V
P=Non-Inductive good-quality Paper, 500V
EH=Electrolytic, 350V.
EL=Electrolytic, 30V.
C35=Only required if anode circuit of V5 refuses to peak to 10·7Mc/s. Then about 8pF ceramic.

Variable Resistors:

VR1 500kΩ log. VR2 5kΩ linear

Valves:

V1	ECC85	V5	EF80
V2	EF80	V6	EB91
V3	ECH81	V7	EBC41
V4	EF80	V8	EF86
CD1	BA1100		

Inductors:

L1 Osmor QA9
L2, 3, 4 Osmor QA8
L5 Osmor QHF9
L6, 7, 8 Osmor QHF8
L9 Osmor QO9
L10, 11, 12 Osmor QO8
AM/IFT 1, 2 465kc/s I.F. transformers.
FM/IFT 1, 2, 3, 4: 10·7Mc/s I.F. transformers.
FM/IFT5 Ratio-detector coil can, 10·7Mc/s.

Switches:

S1 Ceramic rotary switch, 4 position. 3 wafers, 2 poles on each.
S2 Ceramic rotary switch, 2 position. 2 wafers, 3 poles on each.

Miscellaneous:

Chassis (aluminium) 12" x 6", 2" deep.
3/16" Plywood panel, 12" x 6".
Extra small pieces of Chassis and Panel material and brass foil.
3 insulated wanderplug sockets.
7 ½" rubber grommets.
Tagstrip, solder, solder tags, wire, screened cable, bolts, etc.
5 Ceramic Noval Valveholders with cans.
1 Ceramic B7G Valveholder with can.
1 Ceramic B8A Rimlock Valveholder.
1 Panel Pilot-lamp.
4 Pointer knobs.
"Heathkit" FM/RF-Head, Type FMT/4U.

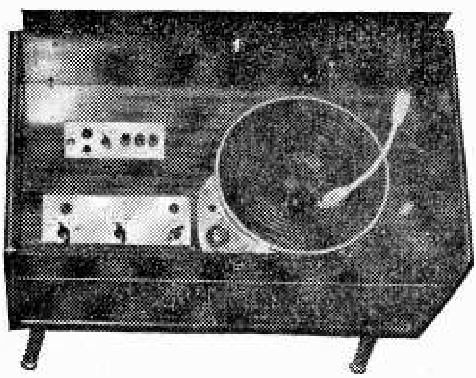
External Connections

The three-core mains lead should be soldered to the mains input tagstrip on the control panel, and also securely clamped at a suitable position on the cabinet. Apart from this, only aerial and loudspeaker wiring remains to be completed.

Loudspeaker Connections

To obtain the best possible quality an external speaker is recommended.

The optimum matching impedance is 7 ohms, but can easily be changed to any other desired value by choosing a different output transformer in the main amplifier. In the prototype a pair of WB Stentorian HF1016 loudspeakers, each 15Ω impedance, housed in corner-cabinets, are connected in parallel to the amplifier output, matching 7 ohms.



The radiogram completed.

These speakers should be positioned, relative to the listener, in roughly the same manner as the two speakers of a good stereo installation. This should here achieve a good "body" for the sound reproduction, spread out evenly in front of the listener. If the reproduction is little better or even weaker than that of a single speaker, or confused, then the phasing is wrong; reverse the connections to one of the speakers.

The simplest test is to observe the cones of the two speakers connected in parallel to a dry-cell (or a maximum of three such cells if needed). The relative phasing is correct if both cones move the same way. Do not operate the amplifier on strong signals without a speaker connected.

Aerial Connections

For a.m. reception, a few inches of wire will bring in the local stations, as the sensitivity is extremely high. However, to make best use of the gain reserves and a.g.c. a good aerial, such as a conventional long-wire, should be used.

The desired station for a switch position on the tuner should be tuned in by adjusting the core of the corresponding oscillator coil, then peaking the mixer coil and aerial coil, in that order. Only the oscillator coil will show sharp tuning.

If the station drifts slightly with time, so that side band splash is heard, only the oscillator coil need be retrimmed. If the drift is frequent, it will be necessary to seal the oscillator coil slugs with a suitable wax.

V.H.F. Aerial

Use the best possible aerial for f.m. reception. The tuner has an exceedingly silent background on f.m.

If the input signal is below a minimum usable strength, the volume will not deteriorate as much as the quality. Severe distortion is probably a sign of insufficient input signal voltage though it could be due to instability or misalignment of the f.m. tuned circuits.

Performance should normally be satisfactory either with a twin feeder or a coaxial downlead from the aerial, but readers are advised to make their own experiments. In either case, always try the effect of reversing the connections to the two f.m. aerial sockets.

Microphony

The audio frequency gain of the complete apparatus is very high. The arrangements are such that trouble from valve microphony is still not noticeable with good valves, and the hum level when both volume controls are at maximum is just still tolerable for good listening.

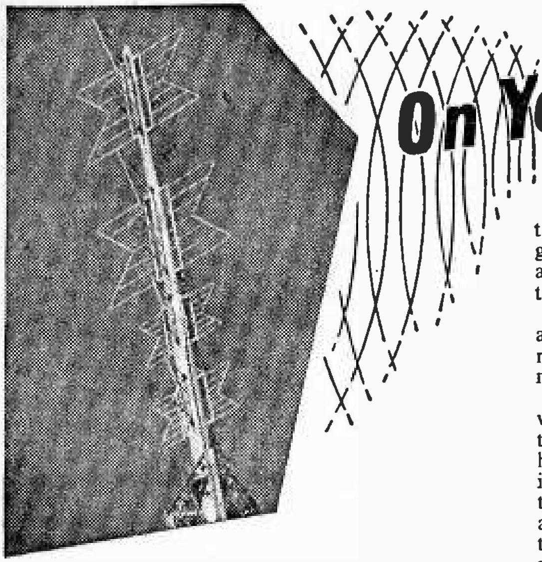
Both volume controls (Tuner, Control Panel) are always operative, and either permits turning the volume to zero irrespective of the position of the other. Correct operation is to adjust the main amplifier volume control on the control panel to about half or two-thirds, and then set the desired output volume on the tuner chassis volume control.

Microphony may also result from the pickup cartridge acting as a microphone. At maximum gain feedback howl may be set up when the pick-up arm is resting on the stationary turntable, acting as "diaphragm". If trouble is experienced even when the pick-up arm is resting on its supporting pillar, then a cut-out switch must be incorporated, or the signal plug removed from the tuner chassis when operating on radio.

Maximum available gain is only likely to be required on f.m. reception where the audio output of the ratio detector is very weak (100mV or so) even though 15V or more rectified carrier may be present. On a.m. reception or record reproduction, nowhere near the maximum available gain is required. Do not over-drive the main amplifier for long periods, as this can cause the screen grids of the output valves to run red hot, leading to early destruction of these valves.

Tone Controls

The range of the treble control is sufficient to suppress heterodyne whistles on a.m. reception at night, or scratching from old gramophone records. The action of the Bass Control, however, may be imperceptible on many types of music, for it is intended only remove the extreme bass in excessively "thumpy" music. ■



On Your Wavelength

By THERMION

MY remarks in the February issue about modern "music" have proved more apt than I thought. Although I have not mentioned this subject for a very long time, acting partly on the assumption that everyone is entitled to his own taste in music, as well as on the number of complaints I had received from readers about this inclusion in my notes, it seems that there is still a very lively interest in the notes.

From the readers who call me a "square" to those who have no interest whatsoever in music, there are endless points of view. Of course, there is a great deal of truth in the old saying that "It takes all sorts to make a world" and "One man's meat is another man's poison", and I don't envy the broadcasting authorities their task of trying to put on programmes to please everyone.

They must have a wonderful time sorting their daily mail, as each programme is undoubtedly followed by letters attacking it and letters applauding it.

But on this question of modern "music" I am certainly not alone and many of the modern so-called tunes are simply tuneless to me, and I am not tone deaf. There is, apart from the needless repetition about which I previously spoke, no "structure" if I might use the term.

The tunes seem quite obviously to be almost the ramblings of an untrained guitar player, who has simply picked on a selection of notes which are easily fingered, and put words to it and bang!, it gets into the Top Ten. I wonder why this is?

Another Hint

My two hints at the end of the last copy have brought some interesting letters and several readers ask for more. Although we did at one time publish a page of such notes from readers. it was eventually found that there were insufficient new ideas, and each post usually contained dozens of letters containing these hints, all of exactly the same idea—generally the use of an old valve base as a plug adapter, or the use of a ball-point pen case as a test prod.

Undoubtedly every reader is aware of the latter and it would be surprising if any experimenter has not used this idea—especially as the prods can be made from red and black discarded pens.

Here is another idea, using these pen cases which might be new to some, but I am afraid at the moment I do not have any other interesting hints, either of my own or from readers. The new idea (at least, it is new to me) is to take one of these pens, remove the ink chamber from inside, and to replace it by an ordinary pipe cleaner of the type consisting of twisted wires with cotton material between them. These are flexible and will be found just to go through the opening in the point.

The pen is then filled or partly filled with "switch cleaner" (not carbon tet. as this has been found to attack certain parts of a radio), and the protruding end of pipe-cleaner—at the top—is bent over and folded and pushed into the top of the pen as a "cork".

This then forms a very useful servicing adjunct for multi contact switches etc., sufficient cleaner seeping round the protruding pipe-cleaner to clean up contacts and if necessary it can be pulled out a little longer and used to take away the dust from between the vanes of a variable condenser which has become noisy. Screw on the cap and it will not leak and can prove a most useful accessory.

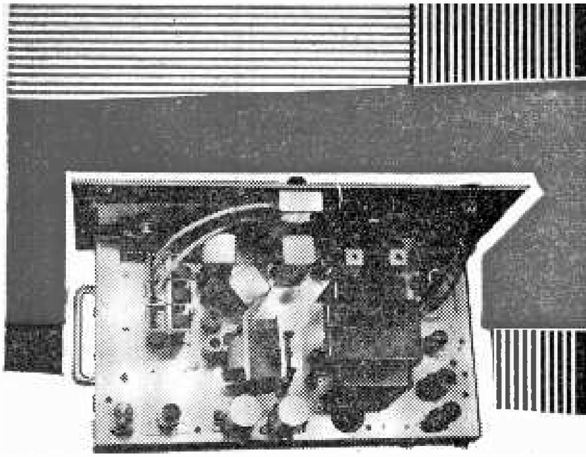
"Quality" Reproduction

Finally, this month I must remind readers that the reproduction of hi-fi music is not such a simple matter as many imagine. Letters are often received asking what tweeter or loudspeaker cabinet to make in order to enable a reader to obtain improved top or bass with their existing set.

They may have heard a modern set on a hi-fi installation and think that similar results could be obtained by adding a tweeter or making a bass resonance cabinet. This is often a fallacy, and it must be borne in mind that very often, especially with old sets, a tweeter would be a waste of money.

It will only reproduce what is fed to it, and although this can go up to 20,000c/s it may be easily possible that the set cuts off even below 10,000c/s and due to its design there may be no response above that frequency so that the tweeter will have nothing to do.

The same remarks apply to the low notes. You may get a more round or smoother tone, but unless other factors are taken into account do not expect that by making a bass reflex or similar cabinet that you will get hi-fi results.



Double Conve Communic Rec

BY P. R. LEWIS

THE starting point for this receiver was the circuit supplied by the manufacturers of a set of short wave coils. Curiously, the circuit was little different from those of any standard broadcast receiver, except for the addition of an r.f. stage and the use of an intermediate frequency of 1·6Mc/s.

Not unexpectedly, performance was not particularly good on the short waves. Sensitivity and selectivity were poor, noise level on weaker signals was high and there was a tendency towards instability when a further i.f. stage was added later in an attempt to increase the gain.

Accordingly, by study of the deficiencies of this receiver and with reference to an excellent series of articles on communication receivers which appeared in PRACTICAL WIRELESS between October 1954 and March 1955, a list was compiled of the various desirable features necessary to give high performance on the short waves. The main points are listed below:

(A) High Efficiency Front End using plug-in coils if mechanical work required would not be too awkward, and using a "flat-out" r.f. amplifier, provided adequate control could be maintained without a.g.c. fed onto this stage.

(B) Separate First Oscillator to give better freedom from "pulling" of the oscillator frequency by strong signals, and to allow more control over the amplitude of the oscillator output fed to the mixer.

(C) Retention of 1·6Mc/s Intermediate Frequency to give adequate image frequency rejection, but,

(D) Introduction of a Second I.F. Frequency of 465kc/s to give extra gain without instability and greater freedom from adjacent channel interference.

(E) Some type of I.F. Filter to reduce bandwidth. This is best introduced as near the beginning of the i.f. strip as possible (i.e. at 1·6Mc/s) and therefore another i.f. stage as this frequency could be added to make up the gain.

(F) A Flexible A.G.C. System.

(G) A Sensitive Detector, possibly in addition to a normal diode detector.

(H) An Audio Noise Limiter.

All these features are, in fact, incorporated in the receiver to be described, a block diagram of which is shown in Fig. 1.

The receiver has a specification better than those of commercial sets selling at over £100. Provided that the smaller components are already to hand in the "spares-box" and that the mechanical construction can be dealt with by the experimenter, it can be built for as little as £25.

CIRCUIT DESCRIPTION

The circuit (Fig. 2) uses Denco Miniature Dual Purpose Coils (Ranges 3, 4, 5), giving an overall coverage of from 1·67—31·5Mc/s. Since the first i.f. frequency is 1·6Mc/s, the *white* oscillator coils must be used. The coils are designed for plug-in applications but, for ease of band-changing, they are mounted in complete sets of three (see paragraph on Construction), and so a separate plug-in unit is used for each tuning range.

Aerial Switching

Provision is made for switching in different aerials, the author using either a vertical wire trimmed by VC1, or one of a pair of loft dipoles sited at right angles (more fully described in PRACTICAL WIRELESS June, 1957).

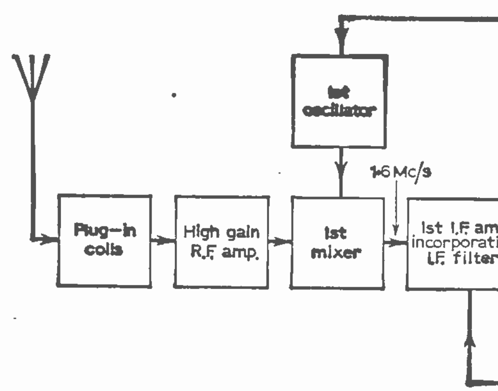


Fig. 1: A block diagram of the receiver.

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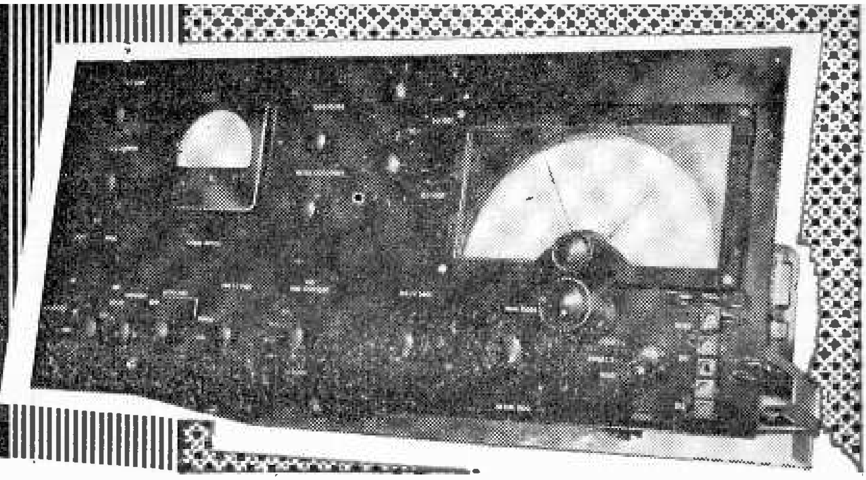


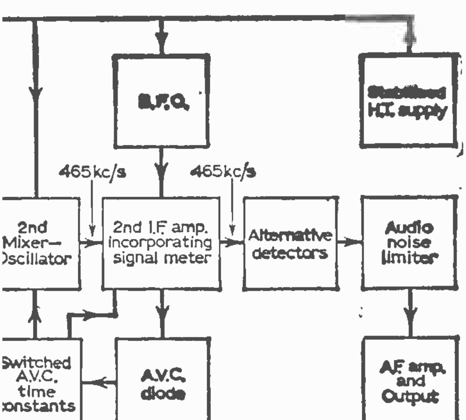
Radio Frequency Amplifier

The r.f. stage employs an EF95 (6AK5), a high-slope low-noise pentode operating under maximum gain conditions. No a.g.c. is applied to this stage as this would inevitably worsen the signal-noise ratio. No overloading has been experienced, even on strong signals, although if it was desired to use broadcast band coils, the insertion of a 50kΩ r.f. gain control in series with the cathode resistor R3 would be almost essential, as it would also be if reception of S.S.B. transmissions was attempted.

The r.f. amplifier and first mixer grid coils are trimmed by the panel-mounted variable capacitors VC3 and VC5. This feature not only saves a number of trimmers but, more important, enables maximum efficiency to be attained at all points on the band. This would not be possible using conventional trimming without the expense of a very high quality ganged tuning capacitor and the labour of adjusting capacitor vanes to give perfect tracking.

First Mixer Stage

A 6BE6 is used for the first mixer since it gives almost complete freedom from "pulling" of the oscillator frequency by strong signals.



Another EF95 strapped as a triode serves as the first oscillator, giving the high output needed for optimum conversion efficiency, this factor being maintained over the whole frequency band by the loading of the oscillator anode with an r.f. choke, L4. The output to the mixer is taken from the top of the anode circuit, this once again reducing any tendency towards "pulling", although in some cases it might be necessary to take the output from the oscillator anode (see paragraph on alignment).

The circuit diagram shows a 30pF Philips concentric type trimmer (TC1) across the oscillator section of the main tuning gang. This is really only necessary to aid tracking if it is desired to use a dial already marked in frequency. If calibration is purely arbitrary, as with a 0—100 scale, this trimmer can be left out. The author did this on the first model after some experiment.

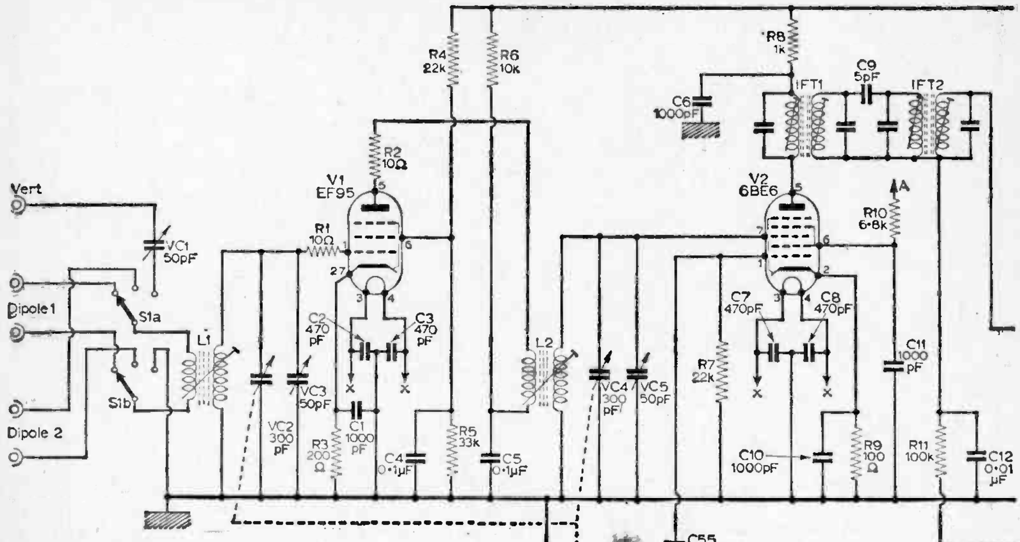
To combat r.f. instability, the heaters of the valves already mentioned are decoupled to either side (as are those of the second mixer and the b.f.o. valves) and 10Ω stopper resistors are freely employed in grids and anodes.

Intermediate Frequency Stages

The i.f. filter consists of a pair of i.f. transformers back to back, loosely top-coupled by C9, which can be made variable if it is desired to alter the bandwidth. However the value of 5pF chosen gives good results and the device as a whole compares well, considering its low cost, with the more expensive crystal filter.

One other device for narrowing the bandwidth was tried—the system popular in the USA of applying reaction to an i.f. stage. In this system the anode is loosely coupled to the grid of the valve, usually by connecting an inch or so of stiff wire to the anode pin and bending it over towards the grid connection. Feedback is controlled by the usual i.f. gain control. The author found this system to be rather vicious, turning the plate of the detector valve red-hot and burning out the IFT.

Both i.f. amplifiers (V3—1·6Mc/s and V5—465kc/s) are EF93's with similar circuitry. The cathode voltages are partially stabilised by resistors taken from the top of the gain controls to the h.t. rail (R15, R30). This prevents flutter due to unstable operation when the a.g.c. system is operating.



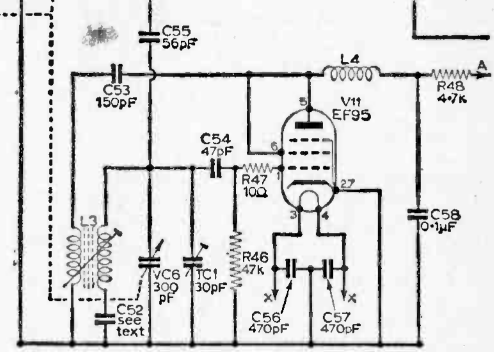


Fig. 2a: Aerial, r.f. amplifier (V1), first mixer (V2) and oscillator (V11) sections of the circuit.

Second Oscillator-Mixer

The second oscillator mixer uses an ECH81. The oscillator coil is a Repanco R03, designed for use over the 1·3—4·3Mc/s range. Since the incoming 1·6Mc/s i.f. is not at the extreme of this range, the coil tunes to the required 2·065Mc/s with a 300pF capacitor across it, this arrangement being preferred, in the interests of stability, to the use of a standard m.w. oscillator coil with very little capacitance in parallel.

The second i.f. amplifier V5 incorporates the Signal Strength meter, which consists of a 0—1mA meter used in a bridge circuit. This mode of operation has the advantage of a positive-going reading with increase of signal strength.

All r.f. and i.f. stages are separately decoupled from the h.t. supply, giving the best possible freedom from inter-action between stages.

Alternative Signal Detectors

The selection of detectors is governed by S4 which gives choice of diode detection (V6a) with adequate r.f. filtering (R31, C34, C35), or of grid detection by a triode (V7a), the latter giving higher sensitivity on weak signals.

Automatic Gain Control

The a.g.c. diode (V6b) can be operated with the cathode at earth potential for straight a.g.c., or with a bias of approximately 2V positive derived from the divider R54, R55 across the 150V supply to give delayed a.g.c.

The a.g.c. can also be shorted out, this being done anyway when the b.f.o. (V7b) is operated. The four modes of operation are controlled by S3.

The a.g.c. time constant (normally about 0·15 seconds in a broadcast receiver) can be varied by S3 from 0·1 to 1·0 second to counteract various types of fading.

The a.g.c. voltage is not fed on to the r.f. amplifier for reasons already mentioned, nor on to the first mixer since this could worsen the conversion efficiency. However, control is extremely good with the arrangement as shown and no amplification of the a.g.c. is needed.

Noise Limiter

The noise filter and crash limiter circuit is a slight varient on that described in PRACTICAL WIRELESS June, 1955, and is very effective on phones. It consists of a high-pass filter, a full-wave clipper, V8 (clipping level controlled by VR6) and a low-pass filter. The filter and limiter can be switched in and out by S5.

Audio Circuit

The a.f. section uses an EF86 (V9) and an EL84 (V10) under normal conditions. The phone take-

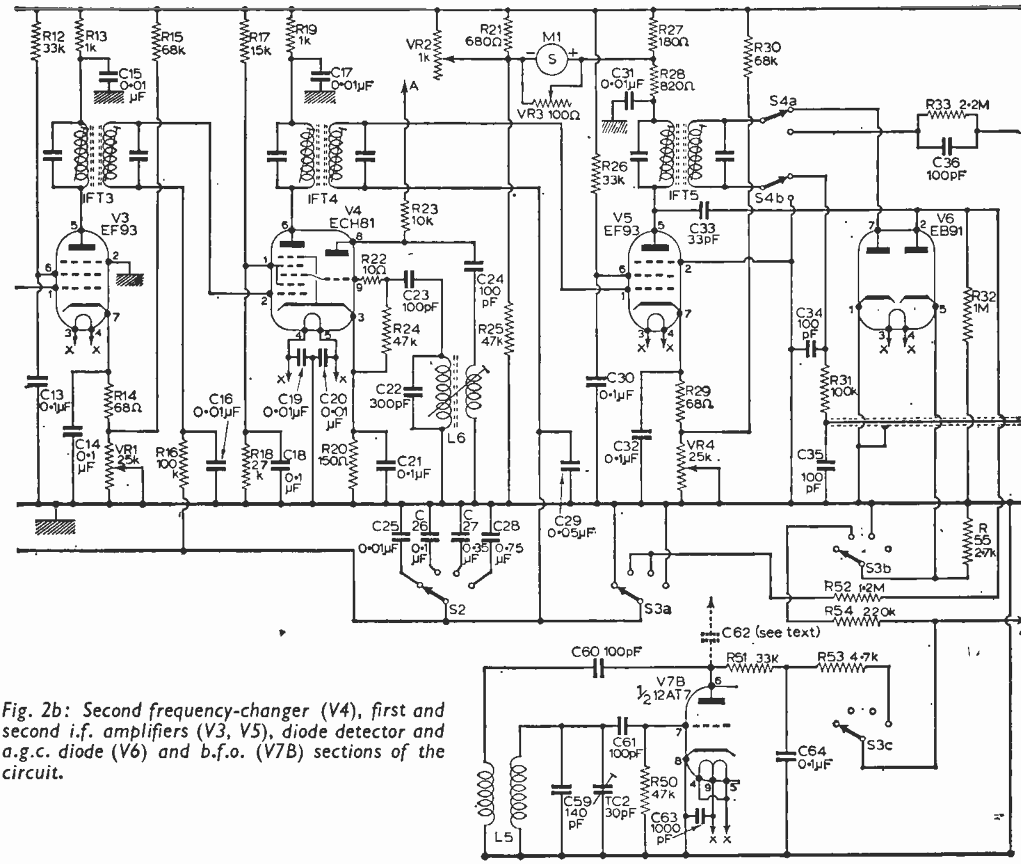


Fig. 2b: Second frequency-changer (V4), first and second i.f. amplifiers (V3, V5), diode detector and a.g.c. diode (V6) and b.f.o. (V7B) sections of the circuit.

off point comes before the output valve and is arranged so that the signal grid of the EL84 is taken to earth when using headphones. Thorough decoupling is employed in these stages; of particular importance are the r.f. by-pass across the output transformer primary (C51) and the r.f. decoupling for the h.t. feed to this section (C48).

Power Supplies

The power supplies are derived from the centre-tapped secondary of the mains transformer T1 via an EZ81 rectifier (V12). The h.t. switch S6 is two-way, wired such that some current is taken from the rectifier (via R56) even when the main h.t. rail is disconnected. This avoids damage to the cathode of the rectifier valve which might otherwise occur due to sudden imposition of high load. The 6·3V heater winding is centre-tapped to minimise hum. If a centre-tapped winding is not available, a 50Ω wire-wound potentiometer can be connected across the winding, the wiper contact going to earth and the control being adjusted for minimum hum.

A 150V gas-filled stabiliser V13 (VR150/40, QS150/40 or CV216) provides a stabilised supply for the oscillators and the first mixer screen.

MECHANICAL CONSTRUCTION AND LAYOUT

With a receiver of this size, it is not possible in the space available to give exact constructional details, and indeed, each experimenter will have his own ideas on the subject.

However, to achieve the desired results, particularly in avoiding instability caused by r.f. feedback from the later stages to the front-end of the receiver, certain points must be observed when deciding the layout.

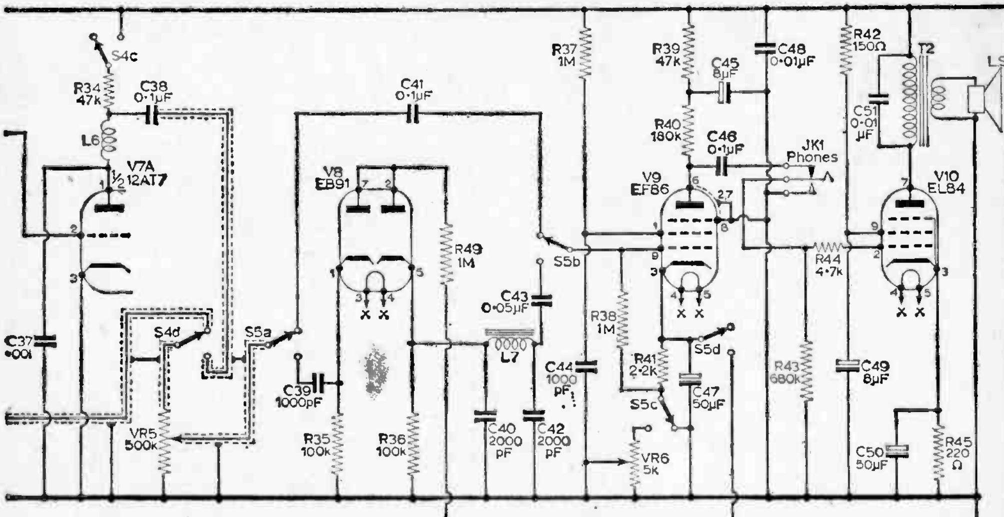
Ideally, the receiver should be laid out in a straight line. This is normally impossible but nevertheless a close approach to ideal can be made by using an L-shaped layout, the front-end and i.f. strip being kept close to the front panel, thus ensuring short connections to most of the major controls.

Chassis and Front Panel

A strong and adequately sized chassis should be used, although it need not be too deep, since wiring-up would be awkward. A depth of 2¼in. is adequate to accommodate the Yaxley type switches, which are the deepest components.

The chassis measures 17in. x 9½in. x 2¼in. and 14s.w.g. aluminium is used throughout. The front panel consists of a piece of ⅛in. aluminium, 18½in. x 8½in.

Long tag strips are arranged to "run alongside" at all stages, providing convenient distribution points for the h.t. rails and the a.g.c. line, and useful soldering points where needed.



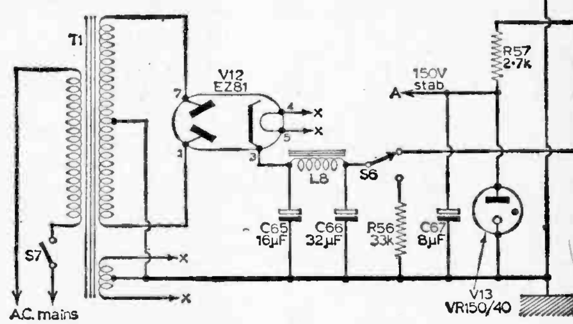


Fig. 2c: Triode detector (V7A), noise limiter (V8), a.f. amplifiers (V9, V10) and power supplies (V12, V13) stages.

The layout followed eliminates the need for valve screening cans in many cases, since the IFT cans perform this function. However cans *are* needed for V1, V2, V6, V7 and V11. Inter-stage screening on the underside of the chassis was not found to be necessary (see section of Setting-up and Alignment in future article). No separate earth bar is needed with the gauge of metal used for the chassis.

TO BE CONTINUED

MINIATURE TEST OSCILLATOR

— continued from page 39

are three in this table—the positions can be identified.

These frequencies, however, even if well distributed over the scale, will not be suitable as scale divisions. To enable the positions of the scale divisions to be ascertained and as a check on the frequencies that have been found, it is necessary to draw a graph.

The use of a logarithmic frequency scale enables the graph for all four scales to be accommodated on a single diagram (Fig. 9), and assuming "lumped" circuit constants, the four graphs would have the same shape if the stray capacitances, including the self-capacitances of the coils, were equalised on the four ranges.

On range 2 there will be fewer whistle positions unless short wave stations are used and these are more difficult to identify with an ordinary receiver. Although the oscillator is unmodulated, it is also possible to detect its presence at points on the receiver dial where there are no whistles by a certain amount of "noise-modulation" which its output contains. This will not necessarily be the fundamental, as modulation acts equally on fundamental and on higher harmonics.

On range 4, if a length of wire is connected to the output to strengthen harmonics, whistles, mostly very faint, can be produced on TV sound if an indoor aerial is connected to the TV receiver and the oscillator is brought close enough. The tuning of the oscillator will be exceedingly sharp and care will be necessary if all the whistle positions are to be located. It will then be necessary to identify at least one of these positions on the short wave band of a broadcast receiver, because otherwise one has the shape of the graph without knowing its correct position on the chart.

There are one or two points to bear in mind:

(a) At an oscillator frequency in the region of 450kc/s (assumed to be the intermediate frequency of the receiver), whistles will be produced indiscriminately on all the stations.

(b) On short wave stations, whistles will probably occur in parts adjacent to each other on the oscillator scale. The weaker one will represent second-channel breakthrough and can be ignored.

(c) The receiver should be tuned right on the station to make sure that the whistle is not due to some adjacent station.

(d) The whistles become quieter the higher the order of the harmonic involved, i.e. the lower the fundamental or first harmonic frequency of the oscillator. ■

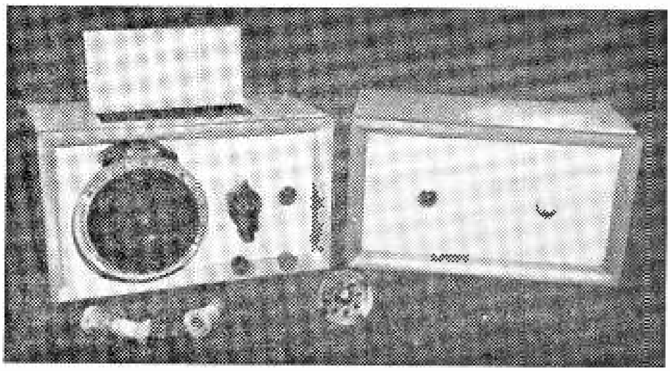
The Twin-Unit Two

PART TWO

A PAIR OF EASILY MADE MATCHING UNITS WHICH COMPRISE A SIMPLE RECEIVER AND A POWER UNIT

by

A. Sydenham



Continued from page 1122 of the April issue.

THE power unit (Unit "B") is very simple—see Fig. 7—a small mains isolating transformer of the type used for pre-amplifiers and the like providing the necessary safety and supplying 6·3V for the valve heaters and panel lamps in addition to a higher voltage which is rectified by V1. Rough d.c. appearing at the rectifier cathode is applied to a filter consisting of R2, C1A and B which smooths it sufficiently before passing it to a socket into which external apparatus of a simple nature such as Unit "A" may be plugged.

Safety Measures

A warning lens is fitted to the front panel together with the on/off switch, while a fixed resistor, R1, provides a discharge path for C1A and B should the external apparatus be removed too soon at any time. If a more rugged unit is desired V1 may be replaced by a miniature contact cooled rectifier unit. Also as a safety measure a torch bulb may be wired in at point "X" to protect the h.t. winding against overload.

Maker's Range No.	Coverage	
	Metres	Mc/s
2	195—560	0·515—1·545
3	57—180	1·6 —5·3
4	20— 60	5·0 —15

Table 1—Coil ranges.

The Panel and Chassis

The overall dimensions of the panel are identical with those used for the receiver unit (see Fig. 4) except that the drilling is different, only two holes being needed—viz., for the lens and the switch. The chassis is slightly larger, however (see Fig. 8), and the outlet socket SK1, which is a standard

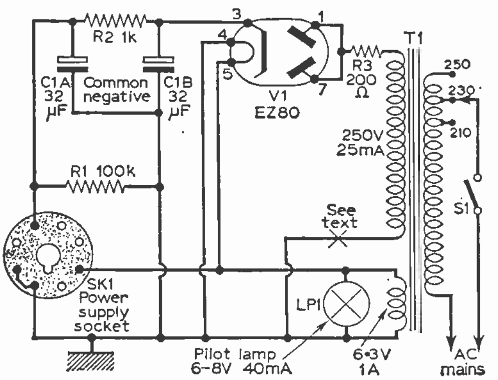
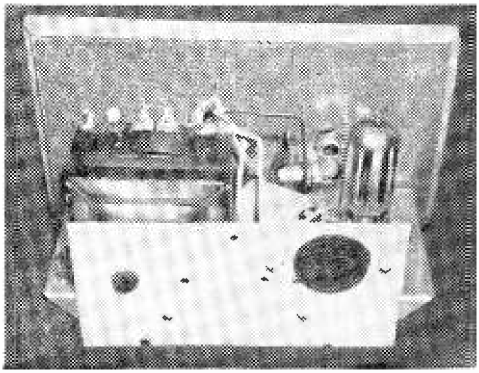


Fig. 7: The circuit of the power unit.



The power-pack complete.

international octal valveholder, is located on a small sub-panel affixed to the rear flange. Both above and below chassis plans are shown in Figs 9 and 10 respectively and it will be noted that leads are anchored to a tag strip, etc., since spare tags on the valve-holder must not be used for this purpose.

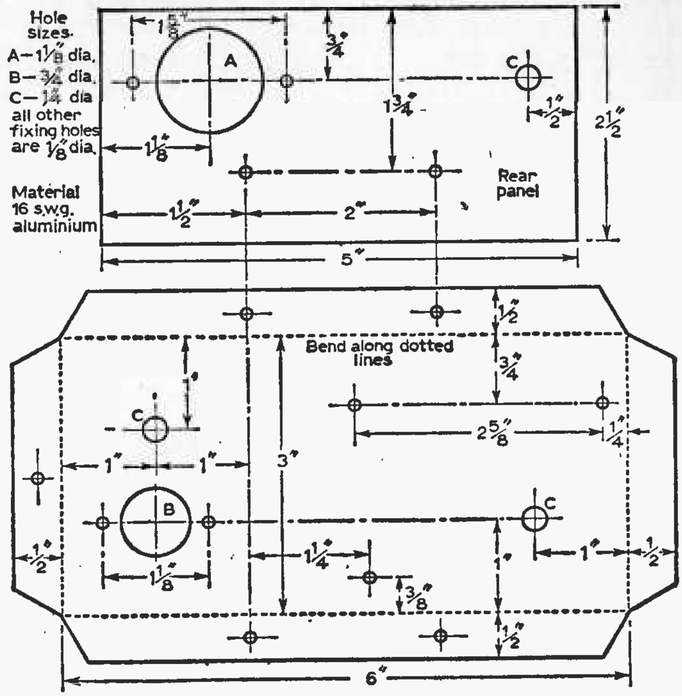


Fig. 8: The drilling details and dimensions of the power-pack chassis and rear panel.

Various types of mains transformer exist suitable for use here, therefore some slight wiring variations are likely with respect to this item. Rigid wiring is essential and the whole must be thoroughly tested for faults prior to bringing it into use.

Testing

Provided no wiring or other faults exist the two units

RECEIVER COMPONENTS LIST

Resistors:

R1	22kΩ 1W	R5	1MΩ
R2	2·2kΩ 1W	R6	47kΩ
R3	47kΩ	R7	1kΩ
R4	1MΩ	R8	22kΩ

(All ½W, except where otherwise indicated)
VR1 50kΩ potentiometer, wire-wound 3W

Capacitors:

- C1 2μF electrolytic 300V
- C2 1,000pF ceramic or mica
- C3 100pF ceramic or mica
- C4 50pF ceramic or mica
- C5 500pF ceramic or mica
- C6 0·01μF ceramic or paper
- C7 1,000pF ceramic or mica
- C8 25μF electrolytic 6V
- C9 0·01μF ceramic or paper
- VC1 500pF variable
- TC1 60pF trimmer

Miscellaneous:

- L1 Miniature coils (Denco, yellow)
  Range 2: 0·5—1·5Mc/s (580—194 metres)
  3: 1·6—5·3Mc/s (180—57 metres)
  4: 5 —15 Mc/s (60—20 metres)
- L2 R.F. choke—see text
- V1 ECC81
- PL1 Octal plug—see text
- LP1 Lamp 6—8V 0·04A

Phone sockets (Radiospares). Two noval (B9A) valveholders. Tag strip. Two spire clips. Lamp holder and lens. Chassis 5 x 2 x ½in.

POWER UNIT COMPONENTS LIST

Resistors:

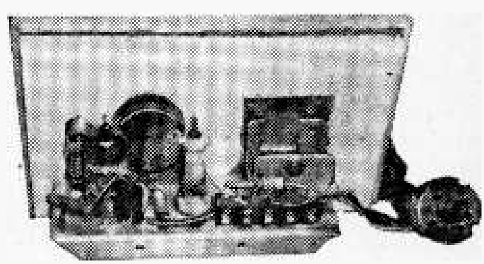
R1	100kΩ ½W	R3	200Ω ½W
R2	1kΩ 1W		

Capacitors:

- C1A 32μF, C1B 32μF } electrolytic 350V
- T1 Mains transformer. Tapped primary. Secondaries: 0—250V 25mA; 6·3V 1A.
- V1 EZ80
- S1 Toggle on/off switch
- LP1 Lamp 6—8V, 0·04A

Miscellaneous:

Tag strip, 3-way. Stand-off insulator. Lamp holder and lens. One noval (B9A) and one 1·0 valveholder (SK1). Chassis 6 x 3 x ½in. Spire clip.



A rear view of the receiver unit.

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★ **(7 Transistor plus 2 Diode design)**

★ Med/Long Waves, Trawler Band and 2 S.W. to approx. 17 metres.

- ★ Rich-toned heavy duty 5in. Speaker.
- ★ Fine for car radio use.
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- ★ FERRITE ROD AERIAL FOR M/L.
- ★ Full After Sales Service.
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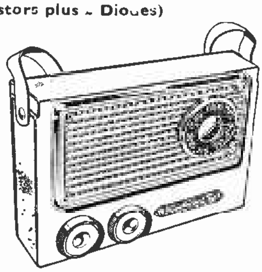
Total cost parts **£7.9.6** P.P. 5/6.

Less Case **£6.9.6**

- ★ Push-Pull output for room filling volume
- ★ Two tone Cabinet with gilt trim
- ★ Case size 12 x 8½ x 3½in.
- ★ Parts price list and data 3/-.

THE SUPER SEVEN

★ ★ **(7 Transistors plus 2 Diodes)**



- ★ 2 R.F. STAGES.
- ★ Coverage of Medium, Long Waves, Trawler Band.
- ★ Telescopic aerial for Trawler Band.
- ★ Use as domestic radio, car radio or fit with strap for carry-about.
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SIZE: 7½ x 5½ x 1½in.

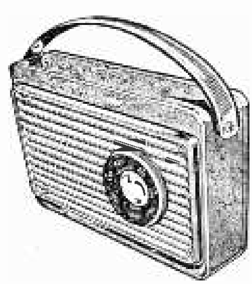
May be built for **£6.5.0** plus 3/6 post, etc.

PARTS PRICE LIST AND EASY BUILD PLANS 2/-

NEW TRANSONA-6

★ **(6 Transistors, plus 2 Diodes, 8-Stage)**

★ **MW/LW**



Powerful magnet 3in. high grade speaker. Push-pull transformers. This is a top performing receiver. Many stations listed in one evening including Luxembourg loud and clear. A pleasure to listen to. **FERRITE ROD AERIAL.** All parts sold separately, grille in red. Uses 9 volt battery. Sockets for car aerial.

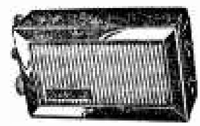
Total building cost **£3.19.6** P.P. 3/-. Size 6½ x 4½ x 1½in.

"Agreeably surprised with Trawler Band reception. Luxembourg as loud as local. Your easy build diagram helped a lot . . . my first attempt."—H. S., Penzance, Cornwall (poor reception area).

PARTS PRICE LIST AND EASY BUILD PLANS 1/6

"POCKET-5"

(MW/LW and TRAWLER BAND) (7 Stages)
(5 Transistors, plus 2 Diodes)



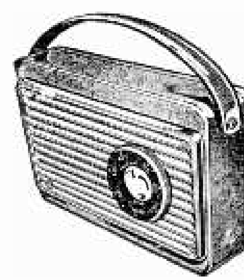
Designed round supersensitive **FERRITE ROD AERIAL** and fine tone moving coil speaker. Attractive case in black with speaker grille in red. On test Home, Light Radio Luxembourg and many Continental stations were received.

Total cost of all parts required **£2.19.6** P.P. 3/-.

EASY BUILD PLANS AND PARTS PRICE LIST 1/6

PUSH-PULL FIVE

(5 Transistors, plus 2 Diodes 7 Stage)



- ★ **2¾in. Super-tone Loudspeaker.**
- ★ **Ferrite rod aerial.**
- ★ Tuning condenser.
- ★ Volume control.
- ★ Case with speaker grille in red.
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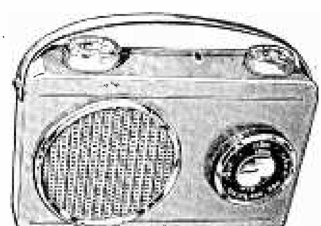
"ROAMER-6"

5 Wavebands (M/L, T.B. and 2 S.W.)



Uses 6 top grade transistors plus 2 diodes. 3in. Speaker. Ferrite rod aerial for sensitivity. Telescopic aerial for short waves. Handsome case with gilt fittings size 6½ x 4½ x 1½in. approx. Listen to stations half a world away.

Total cost of parts **£6.9.6** Post & Packing 3/-.

Plans, parts price list 3/-.

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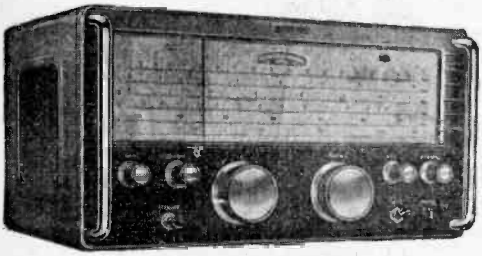

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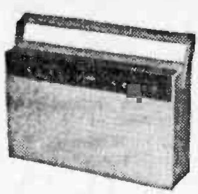

This superhet receiver uses the very latest circuitry, 6 transistors and two diodes and is fully tunable over both medium and long wavebands. First stage uses three Mullard AF.117 alloy diffused transistors with OA.79 and OA.91 diodes, output—OC.81D and two OC.81's in push-pull. I.F. frequency 470 Kc/s. Large internal ferrite rod aerial gives excellent reception over all ranges. 3 inch high flux speaker has a maximum output of 330mW Operates on four 1.5 v. pen torch batteries. All components are mounted on a single printed circuit board. Attractive plastic case with carrying handle—fitted sockets for personal earpieces, tape recorder and car aerial. Size 6¼ x 4 x 1¼in.

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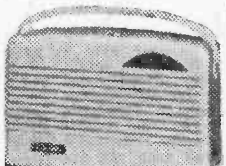

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Fully tunable over Long and Medium wavebands. Uses printed circuit and High sensitivity internal ferrite rod aerial. I.F. frequency 470 Kc's. Transistors: 3-Philco 2067's, 2-Mullard OC81M, OC81DM and OA90 diode. 3 inch speaker. Works on single PP3 battery. Supplied with the complete R.F. and I.F. stages. Driver and Output stages, ready built and mounted on the printed circuit; for final assembly you only have to fit the wave-change switch, tuning condenser and drive, volume control, earphone socket and aerial rod. In very attractive plastic case, size 4 x 2½ x ⅞in. **All parts sold separately.**

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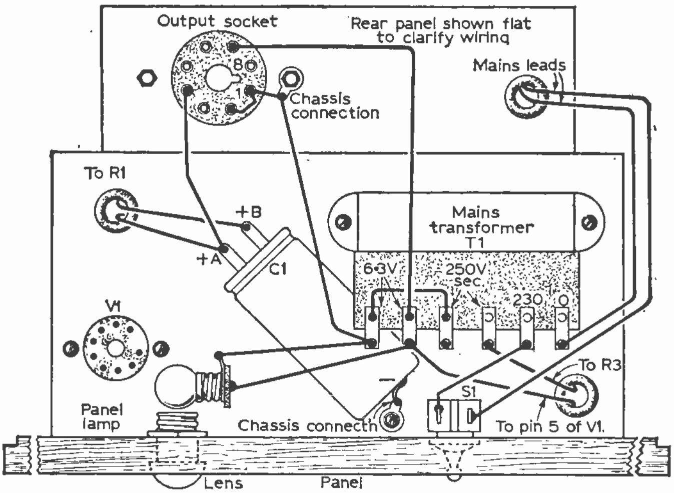


Fig. 9: The above-chassis layout of the power-pack

It is then a relatively simple matter to tune in various transmissions by carefully manipulating the two controls, taking care not to accidentally advance VC1 too far and so cause oscillation. If transmissions tend to "spread" TC1 should be unscrewed to reduce aerial coupling. It will also be found that coverage can be varied slightly by adjusting the coil core, which should be locked by means of a 6B.A. nut when the optimum setting has been found.

If loudspeaker results are required it is a simple matter to feed the output into a small audio amplifier such as the "P.W. Mini-Amp". The prototype receiver was tried with a similar type of amplifier and gave a very lively performance.

may be interconnected, phones plugged in, an aerial connected (a "Windom" type being suitable), etc. A coil from the range shown in Table 1 is then inserted in the socket provided.

Care should be taken to ensure that the locating lug on the coil base coincides with the spare or blank pin position on the valveholder (see Fig. 1). The mains plug may then be inserted in its socket, VC1 rotated to minimum and S1 closed, when the two warning lenses should become illuminated.

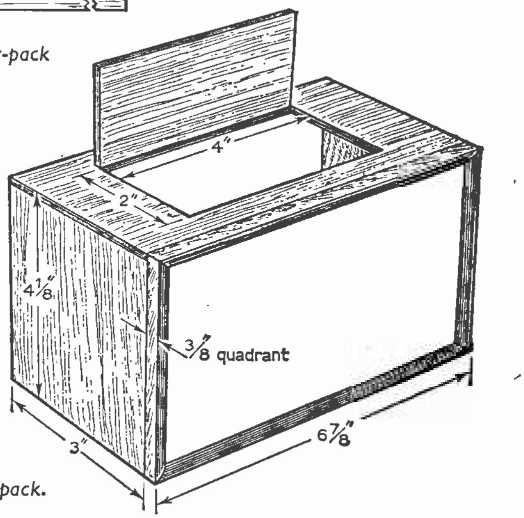
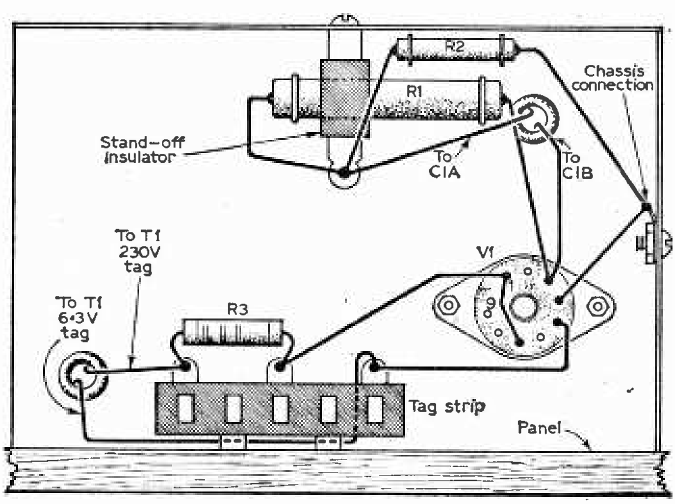


Fig. 11 (right): Details of a suitable cabinet for both the powerpack and receiver units. The hinged lid is only used with the receiver section.

Fig. 10: The underchassis wiring of the power-pack.



Simple Cabinets for the Units

Suitable cabinets may be constructed from plywood or even hardboard and the external dimensions are shown in Fig. 11. Both cabinets are identical in size but a hinged lid is fitted to Unit "A" to permit coil changing, thus providing safety and obviating the need for fiddling about at the back. It might be found more convenient to use a larger aperture here or even to arrange for the whole top to lift up; furthermore, if difficulty is experienced in exchanging coils it is possible to extend either the coil brass stem or fit an extension to the former via the polystyrene locking nut.

The cabinets are easily held together with pins and glue and may be finished to individual taste.

by G.M. and E.C.D.

semiconductors

TALKING POINTS ON CIRCUIT PRACTICE

No. 4—More on Audio Amplifiers

Continued from page 1100 of the April issue

EXAMPLES given in the previous article in this series have emphasised the fact that it is vitally important to make sure that one's input is phased the correct way with regard to the basic working point of the collector load line.

But this does in effect bring us to a point where the mental approach to transistor work becomes important.

A very cursory examination of the facts we have stated above will cause the reader to reach the conclusion that in actual practice the r.m.s. *voltage* swing across the collector load—which normally in valve practice we try to make as large as possible—is going to be very much more than we can possibly pass on to the following stage in the form of base drive.

Consider a stage in which the collector is going to swing, across its load, to the value of some 3 or 4V r.m.s. with signal. Now consider this voltage swing transferred to the base of a following transistor with a gain of 50, the base being biased with a standing current of some 150μA. Suppose the *internal* base/emitter resistance of the transistor to be of the order of 50Ω. This resistance will have in parallel with it values of R1 and R2—which we may ignore because, whatever values they are, in parallel with 50Ω the ultimate resistance in the circuit will be approximately 50Ω. There might be resistance in series, which would alter the case, but suppose there is not—the effective resistance, therefore, is approximately 50.

How many amperes will a voltage of, say, 3V put through the base of a transistor whose internal base resistance is 50Ω? The answer to that is 3/50A, which is far more than the base can possibly take. Assume the base drive to be only 1V r.m.s. One volt through 50Ω is 1/50A, equals 20mA. With a gain of 50 this is 50$\times$20mA in the *collector*=1,000mA=1A.

Let us not press these figures too far, remembering that a transistor is not resistive—that is, does not project a constant resistance under all conditions; nevertheless we are now able to understand why it is found convenient to regard the transistor as a current amplifier rather than as a voltage amplifier.

REDUCING THE VOLTAGE

The fact is that with a loading in the collector of any sizeable value, such as we should need for thermal stabilisation anyhow, we are going to get far more voltage developed across it on signal than we can use. In consequence we have to reduce this voltage before we can pass it on as drive to the next stage, which can hardly be called amplification.

There are various ways of doing this. One is to introduce an interstage coupling transformer with a stepdown ratio, the normal method. Another is to consider the insertion of the coupling capacitor in RC circuits as a source of loss—but this is not satisfactory as a capacitor is reactive to frequency and we want power loss evenly over all frequencies. An excellent method is that shown in Fig. 1 where a load is used sufficiently large to ensure the correct d.c. conditions, but the greater part of it is earthed to a.c. by a decoupling capacitor, leaving only a few ohms across which a.c. potentials will develop.

It is now obvious that with an internal base resistance of a transistor of the order only of ohms, as against many thousand ohms with valves, the drive volts we are going to be able to put on it without driving totally prohibitive values of current through it are going to be severely limited, to a value very much smaller than we will normally get from the collector of the preceding stage; therefore in terms of volts we are certainly not amplifying.

But there is direct current amplification within the transistor itself, small values of input current resulting in large values of output current. It *is* therefore current we are amplifying. We need volts to do it but they are microscopic—it is the steadily increasing *current* swing in each succeeding output that we are using, NOT the voltage swing.

The expert deals with this situation as follows. He reasons like this:

We require a current of, say, 50mA standing in the output circuit so that we can drive a loudspeaker or what-have-you with a current swinging through 100mA (assuming a transistor that will take 100mA), that is to a value of 50 below the Iq

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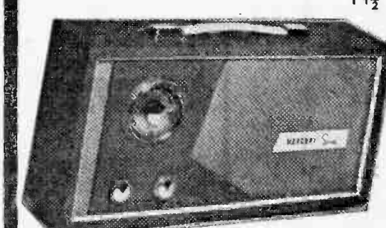

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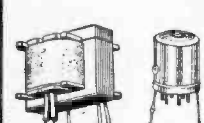

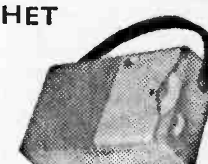

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and to a value of 50 above the Iq, respectively 0mA on the one hand and 100mA on the other. What value of drive current do we require in the base to obtain a standing collector current of 50mA?

If the gain of the transistor is 50, then we need 50/50mA=1mA through the base.

But this is not quite accurate—we must correct for leakage current which flows even with no base bias at all. If Ico is given as 150μA, therefore, the collector current we must induce is 50mA less 150μA and correspondingly the base current we shall require is the base current which will induce 50mA less the base current necessary to produce 150μA of it, which already exists as a leakage.

Unless we are designing for precision apparatus, or the values of Ico are high, we can safely neglect this correction for practical purposes. We need 1mA therefore through the base.

Now willy-nilly we must return to our volts, microscopic though they are, since we cannot get current without potential even if we can have potential without current. How many volts then do we need on the base to drive 1mA through it? Or, rather, how many microvolts?

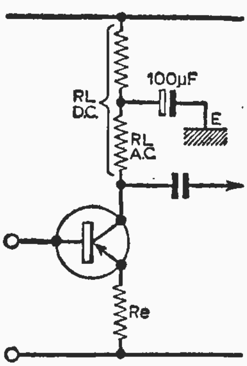

Fig. 1: A method of reducing the voltage developed across the collector on signal by using a large by-pass capacitor across the greater part of the load.

But before we proceed to examine this question we must pause to realise that our volts must come from a source which is capable of *supplying* 1mA. To explain what is meant, using the potential divider method we could place a potential on the base of the right value, but if we made R1 and R2 of the order of megohms, right potential or wrong potential, we would not get 1mA through the transistor, for the potential divider would just not produce it. As soon as the current tried to flow so many volts would drop across the divider that the base potential would drop to zero.

The divider therefore must be capable of supplying 1mA and this condition is achieved if we make it bleed ten times the base current required (we usually have to settle for much less). With the divider passing 10mA, 1mA could be supplied to the base and varied considerably without the actual potential at the junction of the divider varying very much, since this would be controlled mainly by the current flowing through the divider as a whole rather than the much smaller amount taken by the base itself.

We still want to know how many microvolts to place on the base, however, to put 1mA through it.

CALCULATING THE BASE POTENTIAL

This potential will obviously be a product of the resistance in the base circuit. First we have the internal resistance of the transistor itself, say 50Ω. Calculate therefore the volts required to put 1mA through 50Ω. Next we have the resistance in the emitter (Re) if one is used. Calculate the volts required to put 1mA through Re and add that to the first calculation. Finally, since there must be a circuit, the current must return to the base via R2 (and R1 in parallel since we have seen already that as seen by the base they *are* in parallel). How many volts do we need to put our 1mA through R1 and R2 in parallel, being the resistance in the base . . . (and any series resistance, if any)? The sum of these calculations should give us the total potential required to be applied to the base in order to get a current of 1mA flowing through it, and in the collector a current of 50mA. In the emitter there will be 51mA of course since the emitter carries the base current as well.

The answer may well be in the order of some 150-200μV. Which is, as has been said, very much *less* than the voltage swing likely to be existing on the collector of the preceding stage.

The mathematical formula for calculating Vbb (volts on base) is given in Table 1.

Similarly we may calculate what value of base drive in volts will overdrive the transistor, and thus ascertain what r.m.s. potentials (peak) we require from the preceding stage having regard to the expected insertion losses of the capacitor coupling or transformer coupling or whatever is used. There will be no point in having a higher value of standing collector current in the preceding stage (or, indeed, in any) than may be necessary to supply the voltage swing required in conjunction with whatever load we may have.

Table 1:

MATHEMATICAL FORMULAE

Volts on Base (Vbb)

Vbb = IbRb + Vbe + IeRe;
where Ib = base current
Rb = external base resistance
Vbe = base/emitter volts required
Ie = emitter current
Re = emitter resistance.

For a current swing in the collector Is around Iq, the base swing needed will be Is/alpha; and the base voltage: IsRe + Vbe.

MATCHING CALCULATIONS

Class "A" Output

Rl = Vcc/Iq where
Rl is the load required in the collector.
Vcc is the supply volts.
Iq is the standing quiescent collector current.

Transformer ratio is

$$\frac{\text{reflected load}}{\text{total R of secondary and speaker}}$$

where reflected load is Rl minus primary resistance of transformer.

Class "B"

Rc = Rp + m²Rs
where Rc is load impedance per transistor
Rp = resistance of primary.
Rs = resistance of secondary and speaker
turns ratio = m + m : l

In consequence, one sees the stages of a transistor amplifier as a succession of stages in which the output *current* progressively is larger, as stage by stage the current swing produced by the signal input becomes larger needing more standing current to accommodate it. The voltages are negligible owing to the extremely small value of the input resistance of transistors. Perhaps this will answer the question why we do regard the transistor as a current amplifier rather than a voltage amplifier though, in fact, with an associated load it can of course amplify voltages as well . . . but they need to be very small voltages indeed in normal configurations. You can get large voltage swings *out* of a transistor, but without special circuitry you cannot apply them *to* one. You can apply up to 20mA of current to them, however, which at a gain of 50 gives 20×50mA out=1A. Some transistors will do even better than this. Quite apart from the question of linearity then it should now be obvious why it is conventional practice to use the transistor as a current amplifier rather than as a voltage device.

It is no part of our design here to go into various audio amplifier circuits. Let us say that Class A gives higher fidelity than Class B but lower efficiency, some 50% only. The transistors are biased to the mid-point of the load line so as to take both incremental and decremental current swing, therefore each amplifies the whole input wave, the result being additive and in phase in the output circuit. This necessitates a standing collector current of some 50 to 500mA, according to output required, and the battery drain is therefore heavy. This need not matter if the supply is drawn from the mains, but you cannot supply transistors from the mains without special circuitry, which is not inexpensive.

TRANSISTOR TRANSFORMERS

A word now about transformers and matching. Transistor transformers are different from valve transformers . . . for the transistor we need a step-down ratio as has been shown, for one thing. For another, we are transforming current, there is no voltage swing. But the important factor is again paucity of supply. Suppose an output transformer with a primary resistance of 3,000Ω at a current of 50mA and a supply of −9V. At 50 mA 3,000Ω will drop 150V . . . and we had only nine to start with. Hence it is self-evident the first requirement in a transistor transformer is a low d.c. primary resistance . . . it should be somewhere around 1Ω; which implies a secondary d.c. resistance of something like one tenth of an ohm.

The driver transformer can be less rigorous as the currents involved will be smaller . . . here a resistance of some 30-0-30Ω is not uncommon, with a secondary resistance of 1·5Ω. There are transformers on the market with these values, but up to now no output transformers suitable for transistor work have been made commercially. Circuits are published which do away with the need for an output transformer, perhaps because of this. The Majestic Winding Co. of Bournemouth wound an O.P. transformer to specification for the writer and would doubtless do the same for anyone else who desired one.

The usual considerations of matching, leakage inductance, saturation and so on apply. Matching formulae are given in Table 1.

HEAT-SINKS

Finally a word about thermal conditions. In ultimate stages of audio amplifiers the currents can be considerable, and the heating effects therefore also considerable. To ensure the transistor does not exceed its rated thermal limits it may be bolted to a heat-sink which is a square of metal with good heat dissipating qualities. The sink acts as a radiator of heat, and the whole, transistor and sink, are mounted in free air so that maximum circulation of air takes place around it. If the metal body of the transistor is an electrode, as in the case of the OC22 for instance, measures must be taken to insulate the transistor (or the sink) electrically . . . but not thermally. This is achieved by using a thin mica washer between transistor and sink. The sink must be smoothed and polished first, all burrs removed from where the holes for fixing have been drilled, as the slightest roughness, even if imperceptible to the eye, is usually sufficient to penetrate the thin mica washer and produce a short-circuit between the base of the transistor and the sink.

If reasonable precision is required, calculations will be made on the basis of mean or average values for alpha, remembering that this can vary considerably from transistor to transistor. It will be necessary to consider what will happen also if alpha happens to be much less than the mean value taken . . . or, much more. And it will be necessary to decide whether alpha should be taken . . . or alpha bar.

It is impossible in an article of this scope to go into all the possibilities on a non-mathematical basis. The implications of leakage current, transistor, spreads, thermal instability and so on have been discussed before; as also has leakage current. None of these can be calculated without mathematics. In most cases they will not need calculating so long as sufficient margin is left for safety. On the basis of what has been said the reader should be reasonably equipped to understand more complicated text books on the subject if he feels he would like to go more deeply into it.

As we said at the commencement, there are no great problems involved in using transistors as audio amplifiers—if the right approach is made. Remember it is increasing *current* swings we want —and these will be obtained with very small voltage amplification.

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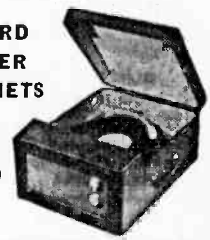

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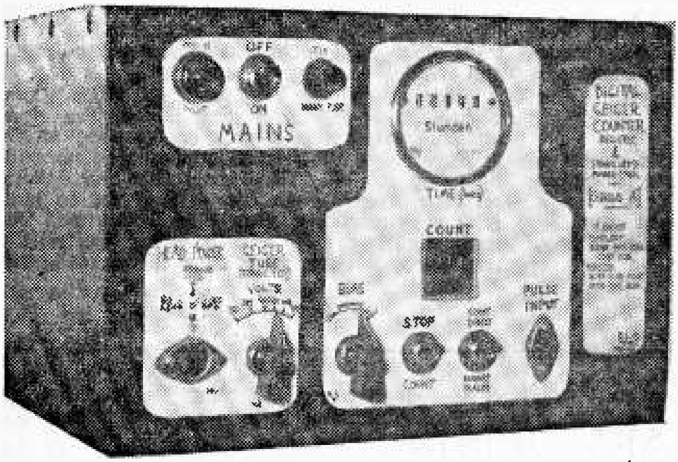
Geiger Counter Digital Register



incorporating Scaler and Power Pack

by
E. Dexter

THIS ARTICLE DESCRIBES A DIGITAL REGISTER FOR OPERATING THE ADVANCED GEIGER HEAD DESCRIBED IN THE DECEMBER 1962 AND JANUARY 1963 ISSUES.

Continued from page 1094 of the April issue

THE S3 position labelled "count direct" causes the digital counter to function exactly as in the original publication, and the new items V6, V7 may be treated as absent. Switching over to the other position, labelled "binary scaler", the following changes take place: A1 breaks the direct pulse feed to the cathode, and any remnant leaking past the self-capacity of the switch is shorted out by B2. Also, B2 shorts the cathode resistor of V8, pin 8, causing this valve to jump to saturation current in the steady state, with the anode voltage low. B1 having opened, the grid pin 7 on V8 is now free to accept pulses from V7 via C15, and A2 having closed, V6 and V7 now receive h.t. and can operate. Upon switching over to binary scaling, V7 will oscillate violently for about a couple of seconds, until C19 has charged. It is thus necessary to switch S3 *before* setting S2 to "start", to avoid a huge initial spurious count.

As pulses are now fed into the grid of V8 instead of the cathode, as formerly, we need *negative* polarity to get again the required positive polarity at V8 anode pin 6 for operating the further stages of the counter. This is the reason why B2 has been made to short the cathode resistor, and run the valve at high standing current—so that negative pulses at the grid can cut it off, giving strong positive pulses at the anode, as required. Only negative pulses from V7, via C15, have any effect. Positive ones are ineffective, as they can hardly further increase V8 anode pin 6 current, as this valve is resting without bias already; and even such slight increases as do take place appear with the wrong polarity at the anode, so that they do not operate V9.

However, there is one danger to be watched. If positive (i.e. unwanted) pulses from V7 cause overswing, due to excessive grid current at V8 pin 7, a sufficiently great inverted post-pulse can result to fire V9 for a count. It is a further function of the grid-stopper R35 to prevent this effect.

OSCILLOSCOPE TESTS

After completing the unit, it should be set operating with its Geiger head and in the "binary scaler" setting. Using an oscilloscope with sine-wave or elliptical timebase, so as not to lose anything in the flyback-time (e.g. Auditron on "Bridge" setting), touch the probe also on to P2. Observe that only alternate pulses are properly and accurately registered. Any trace of response to some, or all of the alternate forbidden pulses means that V8 is probably also responding to some positive pulses from V7, due to the just-mentioned grid current overswing inverting polarity. In such cases R35 must be increased and R36 decreased until the trouble ceases with certainty.

It is *not* possible to check simply by means of attempting to get the registered "direct" count twice as large as the "scaled" count under otherwise the same conditions, as the very purpose of the scaler is to pick up those fast pairs of pulses lost in a direct count due to the inertia of the simple circuit. Thus the scaled count will normally be more than half of the direct count. However, for the pure cosmic background count of the specified MX124/01 tube, the difference should be very small, and thus any great differences there observed probably indicate that something is wrong.

With other tube types, again, this may not be true, as some tubes show a number of low-amplitude head-flimmerings which are missed by the direct counting, but registered by the faster and more sensitive scaler. This question will receive further discussion below; let it suffice for the present to repeat that an oscilloscope is the only certain test. Remember to use Y-gain on the scope to show up any low-amplitude head-flimmerings that may be present.

THE BINARY SCALER CIRCUIT

The electronic generic name of this circuit is "bistable multivibrator", which already describes its function. This circuit is also known as a Schmidt trigger. It is used a great deal in electronic computors, the same as, in a simple way, its present function represents.

As its name suggests, it possesses two conditions for stable resting states, and on account of the absolute symmetry around the two triodes concerned, there is absolutely equal probability for either resting state being taken up. But once one state is taken up, this is maintained until the circuit is *suitably* disturbed to cause it to jump over to the other state.

One stable state is when one triode is cut off and the other drawing heavy current. The other stable state is simply with the roles of the two valves exchanged. Suppose either one triode is the one conducting heavily at any one time. The anode voltage will be low, and thus the grid of the *other* triode, being on a bleeder from the first anode, will be low, lower than the high common cathode voltage developed across C19. Consequently the other triode is cut off. This condition is quite stable, for any length of time whatsoever, until the grids are suitably disturbed by feeding in pulses on C13/C18. If these "disturbing pulses" are positive, both the cut-off and the conducting triode can respond, and mutual interference due to the normal multivibrator cross-coupling (C14/C16) takes place. The net results will be unpredictable and erratic.

However, if the "disturbing pulses" are negative, clear-cut results are obtained. The triode already cut off certainly cannot respond to the negative pulse, but the conducting triode responds by being cut off. This is a stable and definite response, even though the pulse is fed to both grids simultaneously: always the triode that was conducting is cut off, and the other one initially unaffected. But the immediate consequence is that the cutting-off of the initially conducting triode gives a large positive pulse at its anode, which immediately cuts-on the other triode, by normal multivibrator action. And there the circuit stays put for any length of time, the two triodes having exchanged roles. The arrival of the next negative "disturbing pulse" causes the roles to change back again, and so on.

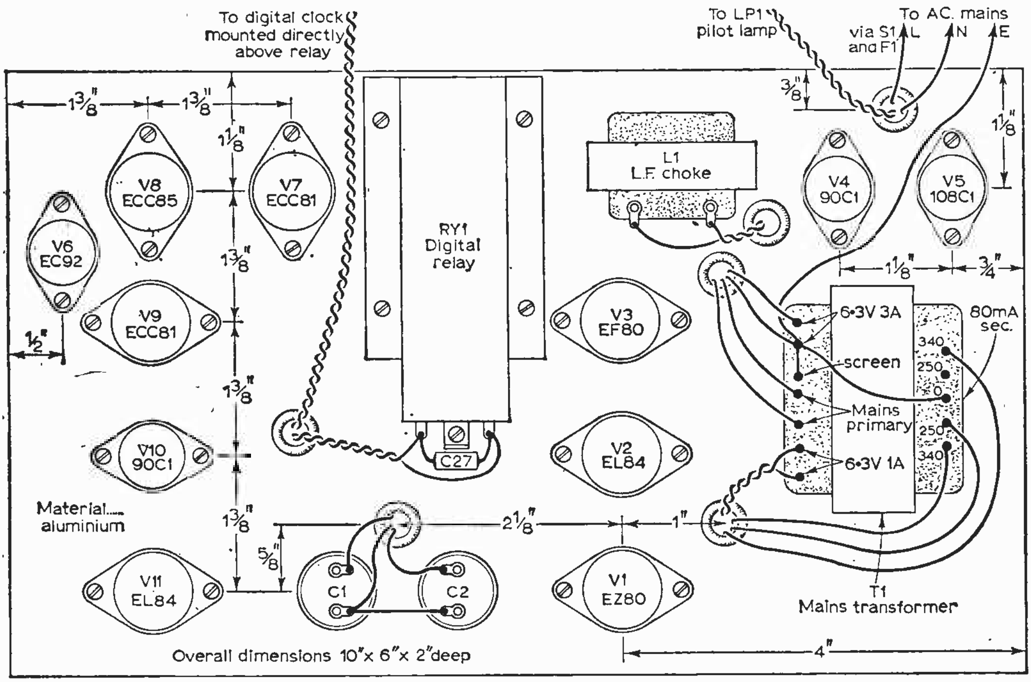


Fig. 3: Above-chassis layout and wiring, showing main drilling dimensions.

DIVIDED OUTPUT

Considering the resulting effects at *either* anode, it is clear that anode current starts and stops coincident with the arrival of alternate negative pulses at the grids respectively. The anode pulse is thus negative for one input pulse, positive for the next, negative for third, and so on. As already explained, the digital counter is arranged to give

HIGH GAIN 4-TRANSISTOR PRINTED CIRCUIT AMPLIFIER KIT
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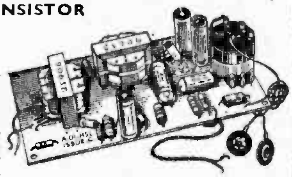

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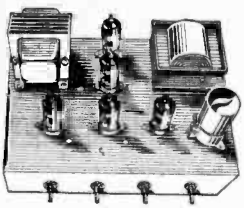

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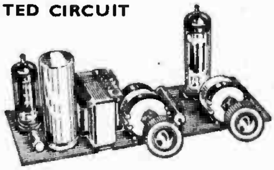

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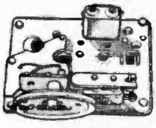

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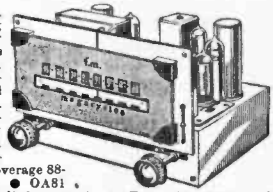

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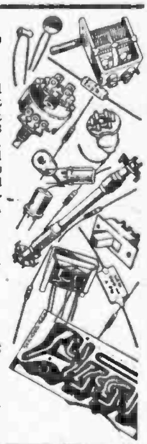

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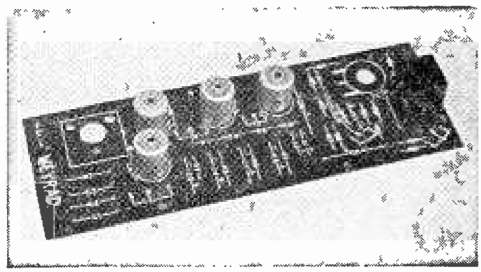

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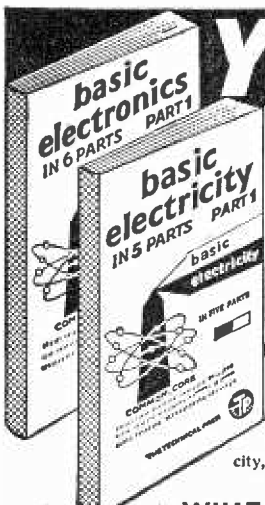

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no response to the positive pulses, counting only the alternate negative ones. The "divide-by-two" process is thus fully explained.

It is unimportant from which anode C15 is coupled to the digital counter proper, as an important feature of the circuit is its *absolute symmetrical equivalence* of its two stages. Indeed maintenance of this symmetry is an important factor for getting proper operation, any gross asymmetry easily leading to "preference" for one state, and erratic division in consequence. For this reason, the "dummy" around D4 is included on the other anode, to simulate the loading imposed by the true output coupling over C15.

PARASITICS

Wiring layout is a less important factor than component values for symmetry maintenance. Thus it is certainly necessary to obtain *matched pairs* of components for all circuitry around V7, yet conditions for layout are far more liberal, as is seen in Fig. 2. Naturally, if we wanted to use the stage for the highest counting-rate of which it is capable, which is probably several megacycles per second, layout would then be equally critical. But that is not the case here; the circuit as specified here is aimed at a resolution of around a millisecond. However, one factor can give trouble, again through the constant danger of parasitics inherent in the use of modern high-slope miniature valves.

Parasitic oscillations at v.h.f., in common with all oscillations, give grid current in the valves concerned, and any starting, stopping or amplitude-changes of these oscillations cause corresponding grid current changes, manifest as being equivalent to voltage pulses at the grid. It is thus clear that if a bistable multivibrator as here under discussion also suffers from v.h.f. parasitics, a variety of peculiar forms of unpredictable behaviour can result.

The annoying thing about this trouble, as far as the uninitiated experimenter is concerned, is that none of the "normal" symptoms of v.h.f. oscillation may be present in most cases, the circuit just refusing to behave as it ought to, even though everything has been checked and re-checked as far as the multivibrator characteristics are concerned. Thus one can waste many hours in a futile search to exasperation, unless one has realised from past experience that such troubles are almost always the result of strong v.h.f. parasitic oscillations—and a couple of grid stoppers almost always effect a complete cure immediately!

LAYOUT

The layout of the wiring around V7 influences the generation of would-be parasitics far more than anything else at the intended operating frequencies. Thus, as soon as the grid stoppers R18, R25 and R28 are inserted, the circuit is extremely tolerant as regards layout. If any instability should be found in V9, it might be better to try increasing the anode resistors rather than inserting stoppers at the grids of this valve. R4, R6, R7 and R51 serve similar functions in the Power-Supply.

Note that grid-stoppers are grid-stoppers, and thus are fully useless unless inserted *absolutely directly* at the grid pin concerned. Even a small fraction of an inch of connecting wire in between is far too long in many cases. One must cut off the connecting wire of the resistor very short, bend

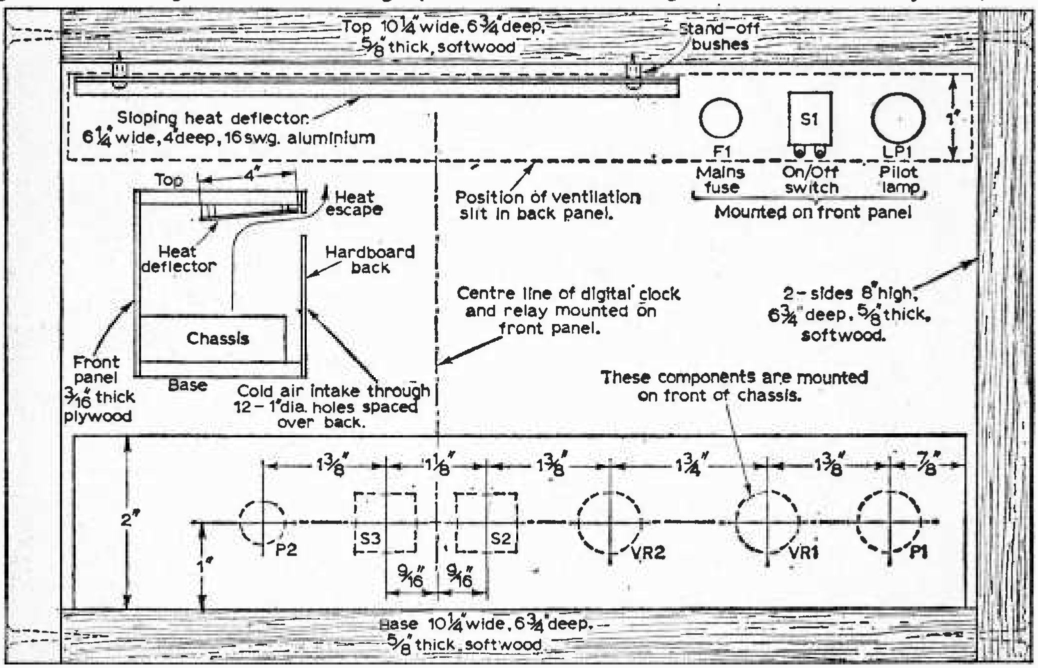

Fig. 4: Back view of cabinet with the chassis in position. The panel drilling must mate with the chassis front flap drilling so that the components concerned clamp the chassis and front panel together as one integral unit. Note the important ventilation measures indicated.

a hook with long-nosed pliers, and solder directly on to the grid pin at the valveholder. Nothing else will do.

PURPOSE OF THE BINARY SCALER

The purpose of the binary scaler is to enable greater counting accuracy to be achieved at speeds approaching the limit of resolution of the mechanical digital relay.

If we were dealing with the counting of a sequence of pulses from a low-frequency oscillator, having a *perfectly regular* sequence, the accuracy of counting would be equally good, however closely the pulse frequency approached the limit of resolution of the digital relay, and in this sense a scaler would be fully superfluous as long as the frequency did not exceed the capabilities of the relay. Inclusion of the scaler would then increase the maximum registrable frequency by a factor of *exactly* two.

However, in Geiger counters we are dealing with an *irregular* sequence of pulses having a mean average frequency characteristic of the intensity of radiation, yet having a randomly fluctuating ("statistical") momentary frequency. Thus, to compensate for the randomly present long intervals between successive pulses, there will be many short intervals representing a momentary frequency much greater than the average.

Such "fast pairs" of pulses will be beyond the resolving capabilities of the mechanical relay, even though the average rate is still well within its capabilities. A fast pair may even temporarily jam the relay, until the next pulse comes, so that *both* pulses of the pair are lost. The higher the average rate, therefore, the greater the chances of fast pairs arriving, and thus the counts registered will be too low by an increasing percentage as the average rate increases.

DIRECT COUNTING ERRORS

We can make a simplified quantitative examination of the practical consequences. Suppose that the switching time of the digital relay in the simple direct digital counter is "t" seconds, where t is some definite fraction of a second. Suppose the *true rate* at which particles of atomic radiation are arriving in the Geiger tube is N per minute, i.e. N/60 per second. Then, because each particle causes a "blockage" for t seconds, the counter is blocked for a portion Nt/60 of a second in each second, i.e. it is inoperative for (100Nt/60)% of the time, which therefore gives the percentage error by which the resulting actually registered count will come out lower than it ought to be.

Taking a simple example of a tenth of a second for "t", and a "true" counting rate of 100 per minute for N (the value, approximately, to be aimed at in preparing concentrated rainfall-samples for monitoring with this apparatus), we see that the error for direct counting is about 17%, which is considerable—though tolerable, because errors in preparation of rainfall samples are likely to be no less than this, and the strength of a chain is only equal to the strength of its weakest link! However, for even faster rates of counting, which are likely to be encountered, errors in direct counting become intolerable.

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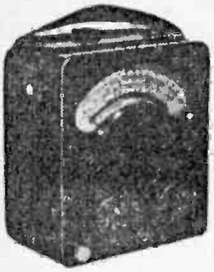

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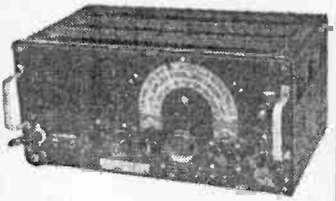

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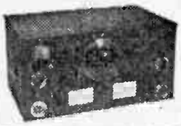

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Making TIN PLATE Chassis

AN ECONOMICAL ALTERNATIVE TO ALUMINIUM CHASSIS

BY L. E. PROFAZE

VARIOUS suppliers offer a wide range of relatively cheap aluminium chassis which are widely used by constructors because they offer advantages to the experimenter in that the metal is easy to work, has an attractive appearance and when folded into box form presents a stable base for radio construction.

One great disadvantage with aluminium is that it cannot be easily soldered. Methods do exist, but they do not lend themselves as readily to good electrical joints as does conventional tin/lead solder which is unsuitable for aluminium, and making earth connections via tags bolted to an aluminium chassis may introduce instability due to imperfect connection through surface oxide layer or the loosening of the fixing screws.

As an alternative material, the use of tin plate offers some distinct advantages insofar that it is very cheap, plentiful, can be cut and bent very easily and does not require a special soldering technique. It is not as stiff as the thicker aluminium normally used for chassis and therefore the finished article tends to be a bit flexible—a condition not always acceptable in radio equipment—but the inclusion of screens both above and below chassis and the fixing of large surface area components will often contribute sufficiently to the stiffness of the assembly to overcome this objection.

By soldering screens in position a very high degree of electrical separation between compartments results, but it should be borne in mind that as the material is of a ferrous character it may have a profound effect on the operation of components sensitive to magnetic influence and should therefore be used with discretion in such situations.

Tools and Equipment

Only simple tools are required to fashion tin plate: a soldering iron, either electric or gas heated, of ample thermal capacity, resin-cored solder of the variety normally used for radio work, a pair of tin snips (or in fact a strong pair of scissors could be used), some pieces of hardwood strip about 1in. x ¼in. and several large spring paper clips (bulldog clips). A couple of small screw clamps would be an additional asset.

Having decided on the size of the chassis the overall size of the piece of tin plate required should be cut from the sheet. This size is determined by adding to the width and length twice the depth of the side and marking out should follow the pattern of Fig. 1.

At the inner corners of the four shaded sections mark with a centre punch (a nail sharpened to a point will do as an alternative) and drill a small hole about a $\frac{1}{16}$in. diameter, then with tin snips cut away the four shaded portions. Make certain the cuts are in line with the folding lines as this will aid in producing a neat finish.

A little practice when using the snips will show how to avoid bending the metal which is to form the chassis, rest one blade of the cutters against the metal which is to be retained and cut with the other, any distortion will then only be in the waste. You should now have a shape as in Fig. 2.

Bending the Tin Plate

This is now ready for folding and you will require two lengths of hardwood strip and the vice or clamps. Cut the hardwood at least as long as the dimension A in Fig. 2 and position one on each side of the sheet adjacent to the folding line and clamp securely. The first bend may now be made and with a little care and practice it will be found simple to form a very neat bend.

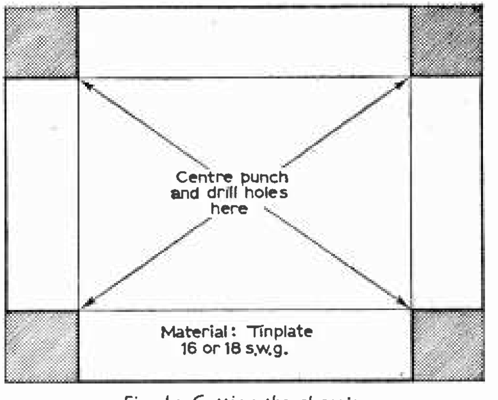

Fig. 1: Cutting the chassis.

This whole procedure can now be repeated on the other long side. For the two short sides the technique is identical except that one piece of hardwood must be cut so that it may be accommodated within the two folded long sides. At this stage the chassis will present a conventional appearance and it only remains to solder the corners to impart additional strength.

With thin metal of this type the application of a hot soldering iron causes expansion and distortion and it is necessary to employ a jig to locate and hold the sides for a neat finish. A suitable jig is

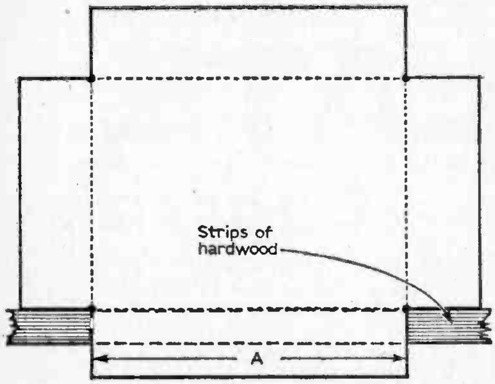

Fig. 2: Bending the cut tin plate

made from two pieces of planed wood joined at right angles to form an L shape into which one corner of the chassis can rest. Its size should be governed by the depth of chassis and in general wood measuring about 2in. x ⅛in. will suffice.

Locate the chassis and secure both sides with bulldog clips (the arrangement can be seen in Fig. 3 although for simplicity only one clip is shown here) and stand the assembly so that the inside of the corner joint forms a trough into which the solder will run. Tilt the chassis backwards a trifle so that the solder is encouraged to stay within the confines of the chassis walls. Before applying the solder it is sound practice to ensure that the metal surface is clean by rubbing the area with a small ball of steel wool.

With a clean hot iron it is a simple task to run in a quantity of solder sufficient to build up a firm reinforcement for the corner. A little practice is required to get the knack of this operation but if the rules of good soldering are adhered to and adequate solder used it will be found both a simple and satisfying process.

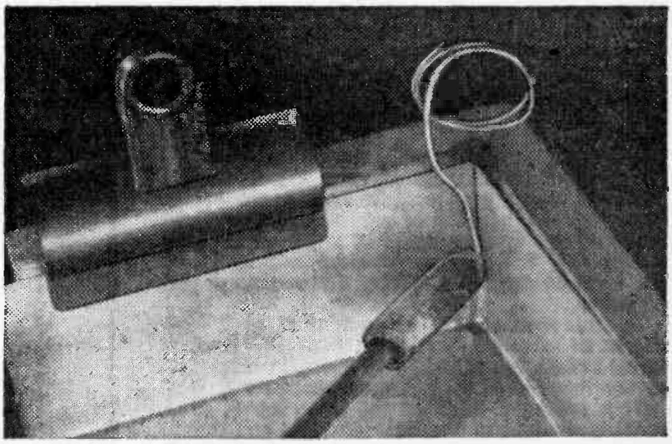

Fig. 3: Soldering the corner joints.

Mounting the Components

Attaching many of the main components is most satisfactorily accomplished by soldering them in position. Holes for valveholders can be made normally with a chassis punch after deciding upon the correct orientation of the valveholder, it can be soldered to the chassis by applying the iron and solder to the fixing lugs which are provided for normal bolting to the chassis. The lugs should of course have been previously cleaned with steel wool.

All leads to earth as well as components such as grid resistors can be soldered direct to the chassis, this being desirable from the point of view of electrical efficiency and stability as well as taking much less time than by earthing with the usual bolted tags. The less-cluttered appearance below chassis can be seen from Fig. 4.

Components such as resistors or capacitors should be secured as normal with soldering tags of which there are many varieties available. A very useful type is that which can be purchased in strips about 1ft long and is composed of a paxolin strip holding a series of tags, every third one having an extension for mounting. Such a strip can be cut according to the length needed and fixed to the chassis by soldering the mounting feet.

Again, should the original position be incorrect an adjustment is rendered easy by unsoldering rather than unscrewing and redrilling and so maintaining a tidy appearance.

Cutting Holes

Experience has shown that some advantage accrues in marking out the position of the main components before bending the chassis sides, and holes for valveholders, potentiometers and variable capacitors etc., should be cut whilst the sheet is still flat. Small holes present no difficulty but when drilling large ones the process is not quite so simple when only hand tools are employed.

The most satisfactory way to achieve an undistorted hole is to clamp the sheet between two pieces of material having the density of perspex or ebonite and then drilling right through, however this is not always convenient especially when the chassis has been formed and already supports a number of other components.

Some of the larger holes can be camouflaged by using non-slip washers for potentiometer shafts and chassis cutters automatically remove the burred material surrounding the initial hole. In other cases the edges of holes can be tidied up quite effectively with the aid of fine round or half-round files.

A word of warning is needed here for care when handling tin plate which has been cut or drilled for the edges are very sharp and produce deep cuts if the precaution of rounding edges with fine emery cloth is overlooked.

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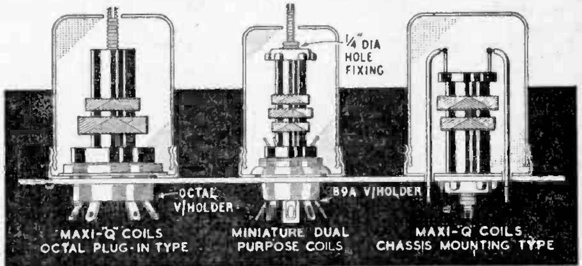

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1L4	3/-	6AN5	15/-	68D7GT	5/-	128Y7	6/-	6146	27/6	EF50	1/6
1N5GT	9/-	6AQ5	6/-	68G7	5/-	12Y4	2/6	9002	5/6	EF55	8/-
1R5	6/-	6A86	5/-	68H7	3/-	20L1	14/-	9003	7/-	EF80	6/-
184	5/-	6A87G	20/-	68J7	5/-	20P3	15/-	ARP3	3/-	EF85	6/6
185	5/6	6AT6	5/-	68K7	4/6	20P4	14/-	ARP12	3/6	EF86	6/-
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1U4	7/-	6B7	5/-	68Q7	6/-	25Z5	8/-	AZ1	9/-	EF98	10/-
1U5	7/-	6B8	5/-	6887	3/-	25Z6GT	8/6	AZ31	7/6	EF183	10/-
1Z2	22/6	6B8G	2/6	6V6G	4/-	26A7GT	15/-	C1C	8/-	EF184	10/-
1X2B	7/-	6BA6	5/-	6V6GT	7/-	28D7	7/-	CL33	9/-	EFP60	10/-
2A3	5/-	6BE6	6/-	6X4	5/-	30C15	10/-	CY31	6/-	EL32	3/6
2D21	6/-	6BH6	5/-	6X5G	4/6	30F5	8/6	DAF96	7/6	EL33	9/-
2E26	20/-	6BJ6	8/-	6Y6G	6/-	30FL1	9/6	DF96	7/6	EL34	10/-
2X2	3/-	6BR7	11/6	7B7	8/-	30L15	12/-	DH63	6/-	EL41	8/-
3A4	4/-	6BR8	5/-	7B8	8/-	30PL1	10/6	DK92	9/-	EL42	8/-
3A5	7/-	6BW6	9/-	6Z4	5/-	30PL13	10/6	DK96	7/6	EL81	9/-
3A8GT	8/-	6BW7	9/-	7C5	12/-	35L6GT	8/-	DL96	7/6	EL83	7/6
3B28	15/-	6C4	2/6	7Z4	4/-	35W4	6/-	E1T	45/-	EL84	7/-
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5Z4	9/-	6H6	1/6	12BE6	5/-	815	40/-	ECC32	4/-	EZ80	6/-
5Z4G	7/-	6J5G	3/-	12BH7	8/-	829B	50/-	ECC34	10/-	EZ81	6/-
6/30L2	10/-	6J6	3/6	12BY7	10/-	832	15/-	ECC40	9/-	G810A	25/-
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6A6	5/-	6J7G	5/-	12H6	3/-	866A	14/-	ECC84	8/-	HL41	4/-
6A8MG	7/-	6K6GT	6/-	12J5GT	3/-	954	5/-	ECC85	8/-	KT41	12/6
6AB4	6/6	6K7	5/-	12J7GT	7/6	955	3/-	ECC88	15/-	KT66	15/-
6AB7	4/-	6K7G	2/-	12K7GT	7/-	956	2/-	ECF80	10/6	KTW61	7/-
6AC7	3/-	6K8	8/-	12K8	10/-	957	5/-	ECF82	8/-	KTZ41	6/-
6AG5	3/-	6L5G	6/-	12Q7GT	5/-	958A	4/-	ECH22	15/	ML6	6/-
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combinations of chassis can result from the application of simple geometric and engineering principles. The small bracket shown in Fig. 4 is typical, the shaft bearing originated in a defunct potentiometer. A right angle bend or two partitions set at right angles can impart a remarkable degree of stiffness whilst performing the function of electrical screening.

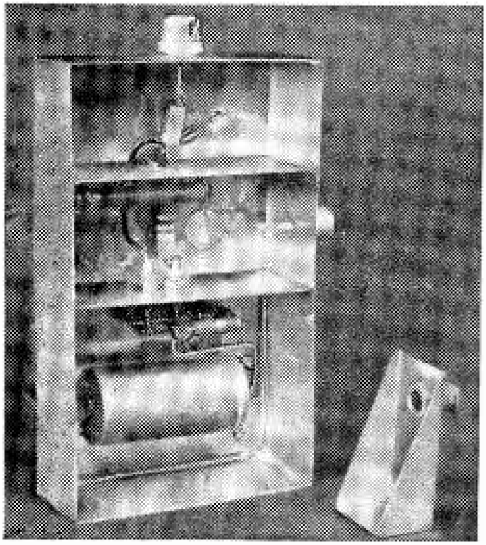


Fig. 4: A finished chassis and a strengthening bracket.

Permanently Fixed Nuts

It very often occurs as a piece of equipment progresses that it is necessary to remove temporarily a particular section or major component which during the earlier stages of construction was easily accessible but later becomes crowded in with other components so that although the fixing nuts can be removed quite easily, replacing them becomes a task requiring both ingenuity and patience. If before fixing, the nuts (preferably of brass) are soldered in position the screws can be used as normally with the advantage that their subsequent removal and re-entry is rendered easy.

When soldering brass nuts some solder will inevitably enter the thread but this yields to the introduction of the appropriate tap. This method may also be used for the linking up of two or more sub-chassis to form a complex final assembly which would otherwise be unwieldy if built as a whole.

The complete unit constructed by this method presents a perfectly satisfactory appearance and should perform well electrically. There is the additional reward of achievement and considerable economy together with the convenience of being able to produce a tailored chassis without delay, even if this idea is only used as a stand-by measure for the production of prototype units or temporary experimental set-ups.

The ease with which tin plate can be fashioned makes it an attractive material for many radio and electronic purposes, whilst this is not the limit of its scope as will become apparent to anyone who is converted to its use. ■

CORRIGENDA

Electro-Mechanical Echo Unit

The diagram given below should be substituted for the circuit of a power unit which appeared on page 1114 (April 1963 issue).

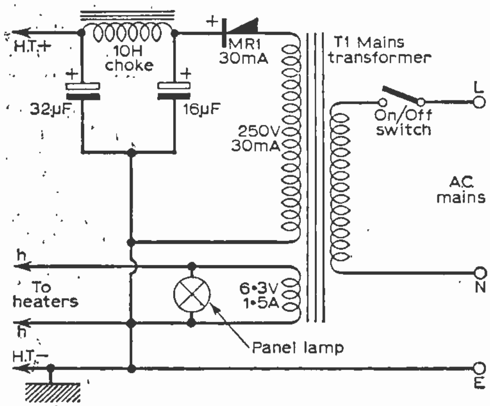


Fig. 3 (above): The power unit.

A Simple Filter Network

In Fig. 3, page 824 of the January 1963 issue, the heater wiring of the ECC83 valve should be amended as follows: link together pins 4 and 5, disconnect pin 9 from chassis. One side of the 6·3V supply is now applied to pins 4, 5 and the other side to pin 9.

Amend the Components List to read: C7 4,700pF ceramic or mica.

Test Gear Techniques

In the Equivalences Table on page 900 (February 1963 issue) the resonant frequency (fr) is given in Megacycles, not in kilocyles as stated in the footnote to the formula

$$fr = \frac{1}{2\pi\sqrt{LC}}$$

CLUB NEWS

CLIFTON AMATEUR RADIO SOCIETY
Hon. Sec.: C. Godsmark, G3IWL, 211 Manwood Road, London, S.E.4.

On March 15th members enjoyed a lecture by G3NWF, when his subject was "Transistor Transmitters". The demonstration which followed was also well received.

The April meeting took the form of a quiz, with G3OGE putting the questions. The members' scores from this quiz count in the annual club championship.

COVENTRY AMATEUR RADIO SOCIETY
Hon. Sec.: A. J. Wilkes, G3PQQ, 141 Overslade Crescent, Coundon, Coventry, Warwickshire.

At the first meeting in March, G3CZS elaborated on the account he gave last September of his continental holiday of 1962, when he met many foreign amateurs through the International Ham Hop Club.

March 18th was Junior Quiz Night and on the 25th, G3NAP gave an interesting talk on "Mobile Operation".

DERBY AND DISTRICT AMATEUR RADIO SOCIETY
Hon. Sec.: F. C. Ward, G2CVV, 5 Uplands Avenue, Littleover, Derby.

The lecture given by G3FOP on March 13th—"Car Radio Interference Problems"—proved of interest to all those members who attended. After an "open evening" on the 20th, the Hot Pot Supper of the 27th went down very well.

A sale of surplus items of equipment was held on April 3rd.

FLINTSHIRE RADIO SOCIETY
Hon. Sec.: A. Antley, "Fairholme", Fairfield Avenue, Rhyl, Flintshire.

The only meeting of this Society in March was held on the 25th, and after the usual morse practice there followed an interesting lecture by L. W. Barnes called "Simple Hints and Kinks".

This was followed by another lecture—"Fault Finding"—which was given by J. T. Lawrence.

GRIMSBY AMATEUR RADIO SOCIETY
Hon. Sec.: B. Walster, 47 Richard Street, Grimsby, Lincolnshire.

Those wishing to join in the Grimsby Society's "Old-fashioned Hamfest" to be held on May 12th at Cleethorpes, should contact the secretary, Mr. Walster. The tickets, which include the cost of high tea and car parking facilities, cost 10s. each.

LOTHIANS RADIO SOCIETY
Hon. Sec.: W. T. Sutherland, GM3JWS, 47 Great King Street, Edinburgh 3.

The subject of Mr. Russell's lecture, which he gave on March 14th, was the "History of Automobile Communications". The lecture on the 28th—"Electronics"—was the result of the combined efforts of GM3OWI and GM3LCP.

MEDWAY AMATEUR RECEIVING AND TRANSMITTING SOCIETY
Hon. Sec.: P. J. Pickering, G3ORP, 101 Chatham Road, Maidstone, Kent.

On March 4th members had a chance to discuss the future dates on which their fortnightly meetings should be held. Later in the month there was a constructional competition open to all members: this was on the 18th.

April 1st was "Tramps' Night", when members began the month's programme of events with a very enjoyable evening.

MELTON MOWBRAY AMATEUR RADIO SOCIETY
Hon. Sec.: D. W. Lilley, G3FDF, 23 Melton Road, Asfordby Hill, Melton Mowbray, Leicestershire.

On March 14th, the Rev. A. W. Shepherd was host to those members of the Society who made a visit to his shack, and on the 21st he was again kept busy with a demonstration of amateur radio at Grimston.

Future Event: April 18th—"Transmitter Construction for N.F.D." by G3OWR.

MIDLAND AMATEUR RADIO SOCIETY
K. Morton, G3OVQ, 58 Burns Road, Coventry, Warwickshire.

The Rally Organising Committee of the North Midlands Mobile Rally has announced the date for the event as April 21st. This rally, which is organised jointly by the Midland and Stoke-on-Trent Amateur Radio Societies, will be held at Trentham Gardens, Trentham, Staffordshire.

Attendance figures for this rally last year mounted to more than 4,000 and it is hoped to better this number this year. Talk-in stations will be G3GBU/A on 160m. and G3MAR/A on 2m.

MIDLAND RADIO CONTEST CLUB (G3RSR)
Hon. Sec.: J. J. Lockyer, G3OVA, 153 Ivor Road, Birmingham, 11.

As the name suggests, the main aim of members of this society is to enter as many contests as possible. The society has its own clubroom at an ideal site on a hill eight miles out of Birmingham, and meetings are held on the first Friday in each month at this H.Q.

MID-WARWICKSHIRE AMATEUR RADIO SOCIETY
Hon. Sec.: T. Inkester, 13 Dormer Place, Leamington Spa, Warwickshire.

At the recent Annual General Meeting, this Society elected its officers for 1963. Those members who wish to sit the R.A.E. can take advantage of the course of instruction in radio theory, which the Society arranged with the Mid-Warwickshire College of Further Education.

NORTHERN AMATEUR RADIO MOBILE SOCIETY
Hon. Sec.: B. Crisp, G3LHQ, Ashmount, Moorhouse Lane, Birkenshaw, Near Bradford, Yorkshire.

The date for the Northern Mobile Rally, which is organised by this Society, is announced as being Sunday, May 26th. Once again this event will be held in the grounds of Harewood Park, near Leeds.

—continued on page 82

R.S.G.B. Contests for April: *Low Power Contest (April 6th and 7th) and D/F Qualifying event (April 21st).*

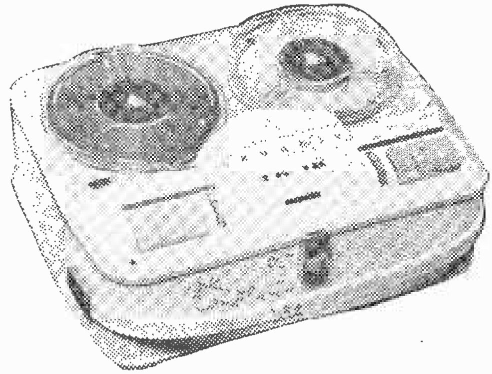
"INSTANT AMATEURS"

THERE is no short-cut to becoming a licensed amateur transmitter. This is a fact we are constantly repeating for the people who write to the Editor wanting to know "where can I get a transmitting licence, and how much will it cost?" Not that we resent these enquiries, as most often the writer is a very young enthusiast who has just had his first success with a crystal set and now wants to "spread his wings" somewhat. However, it is as well for any potential ham to bear this fact always in mind, as there is no stimulus for pre-R.A.E. studying in searching for an easy way to get a "ticket".

Many argue that the R.A.E. is unwarranted and licences should be issued on demand, or that certain concessions should be made so that the public could make use of part of the frequency spectrum, on similar lines to the American Citizen's Band. But whatever the rights and wrongs of these arguments may be, the fact remains that under the present system the law requires that anyone wishing to use a radio transmitter, must take and pass tests, not, as most opposers to the schemes seem to think, to keep the number of licensed amateurs down to a manageable few, but to satisfy the authorities that those using the allotted frequencies will not abuse the privilege.

Then what is the use of all this argument?—just so much wasted time which could have better been spent studying. As far as we know, there is no product at present on the market promising "instant amateurs", and so concentrated effort seems to be the only sure way to that precious licence.

Trade News



The model TK18 tape recorder from Grundig Ltd.

TAPE RECORDER

THE model TK18 tape recorder is a new single-speed model from Grundig (Great Britain) Ltd. This recorder incorporates as a recording level control, a "Magic Ear". This is an automatic sensing unit which has a specially designed control valve which feeds information to all three amplifier stages, including the frequency correction network.

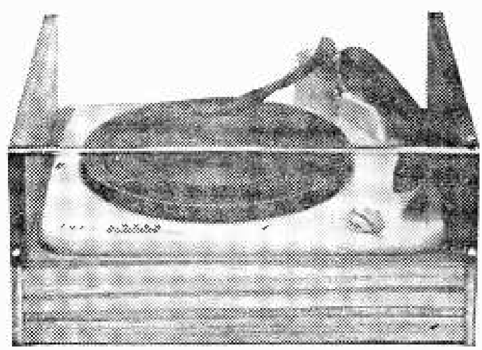
The frequency of the TK18 is 40 to 12,000c/s, and the running time per tape is one hour each track. The internal loudspeaker is a $5\frac{1}{4}$in. x $4\frac{3}{4}$in. elliptical type and a moving coil microphone is supplied. The valve line-up of the amplifier is ECC83, ECL86, EM84 and the output power is 2·5W.

The price of the TK18 is 39 guineas and the makers are *Grundig (Great Britain) Ltd., Newlands Park, Sydenham, London, S.E.26.*

RECORD CHANGER

AT the recent international radio and electronics exhibition held in Paris, Telefunken exhibited a wide range of their valves, semiconductors, components, tuners and record player chassis. Among these was the TW504 record changer. The de Luxe version of this model is presented in a polished wood cabinet with a hood of smoked glass.

The Telefunken agents for the U.K. are *Welmec Corporation Ltd., 147-148 Strand, London, W.C.2.*



This new record changer is made by Telefunken.

A new miniature microphone made by Amplivox Limited.

MINIATURE MICROPHONE

A NEW development of Amplivox Limited is a miniature hand microphone, which is called the Mini-Mike. This can be used at the lapel as both microphone or reproducer.

Although very small, the Mini-Mike contains a sensitive electro-magnetic capsule having a sensitivity of -79dB referred to 1V/dyne/cm^2 at 1,000c/s. Single and double pole finger-tip switching enables this microphone to be used with pocket transmitters and as a useful accessory for miniature tape recorders and dictating machines.

The manufacturers are *Amplivox Limited, Beresford Avenue, Wembley, Middlesex.*

Letters to the Editor

The Editor does not necessarily agree with the opinions expressed by his correspondents

Whilst we are always pleased to assist readers with their technical difficulties, we regret that we are unable to supply diagrams or provide instructions for modifying commercial or surplus equipment. We cannot supply alternative details for receivers described in these pages. WE CANNOT UNDERTAKE TO ANSWER QUERIES OVER THE TELEPHONE. If a postal reply is required a stamped and addressed envelope must be enclosed with the coupon from page iii of the cover.

LANGUAGE BARRIER

SIR,—I must agree with Mr. A. Jameson (Letters to the Editor, March) on the use of Esperanto for communication between amateurs on short waves. It is an ideal language for this purpose and can easily be studied at home.

Berne, Hilversum, Vienna, Rome, Paris, and some South American transmitters already use Esperanto as well as their national languages for some of their broadcasts.—J. BROWNLEE (Hexham, Northumberland).

SIR,—With reference to Mr. A. Jameson's letter (March, '63) concerning the use of Esperanto for radio amateurs, he does not appear to be aware that for some considerable length of time amateurs have been communicating universally without the use of this language. From his short wave listening, Mr. Jameson should have realised that most foreign amateurs are sufficiently educated so as to speak English almost fluently. (I have frequently found this the case).

Also, if a message is sent in French, it is generally meant for a Frenchman, or if in Spanish for a Spaniard, etc. So why waste time trying to learn a language which would probably cause more confusion than ever. — N. COLLISTER (Gloucester).

NORTHERN COMRADESHIP

SIR,—I have found reason to agree with the observations expressed on the Club News page in the March issue. In Walthamstow, a London borough of many thousands, no radio club has been possible for years. I have attempted to work on behalf of the club movement in this area for some years now, and always the members tend to visit any particular club meeting only if the subject is directly suitable for them. I don't think this is basically selfishness, but reflects a general impatience on the part of the "rushed" nature of Southern living.

Also members often admit to me that they don't visit the club to meet others, but at the Northern Polytechnic College, where we have now established a radio club and where a great number of members are *Northern* amateurs working as students in London, *they* do state that they go to a club primarily to meet people and hear about their work.—K. L. SMITH (London, E.17).

MODERN ENGLISH USAGE

SIR,—I am writing about a word used very frequently and which has puzzled me a lot. The word is "transistorised".

I ask myself, is a valve set "valve-ised"? And as I think of this I become convinced that the English language is being slowly murdered, and so I will relate what happened to my receiver when it was serviced recently.

The set, having gone faulty, was taken away by a man in his "petrolised" vehicle, or maybe it was a "dieselised" vehicle. Anyway, he probed around in this set, first in the "resistorised" section, then in the "condenserised" part, and finally found the trouble in the "valve-ised" section. I can only add that when I received his bill I was *paralysed!*—C. H. OGILVIE (South Shields, Co. Durham).

MISSING CLUB

SIR,—Some eighteen months ago, when I moved from London to my present address, there came to light along with many other forgotten treasures, my old B.L.D.L.C. membership certificate, dated April 4th, 1939, and my lapel badge. This set me wondering what became of the British Long Distance Listeners Club and recently I got round to going through my back numbers of PW to find out.

The last club notes to be published were in the issue dated May 1943, yet nowhere can I find notice of the club being wound up or suspended. Neither do there seem to have been any letters from members querying the future of the club. The very last reference of all seems to be in a letter to the Editor, published in the issue of August 1946.

There must have been a good reason why the B.L.D.L.C. was not started up again after the last war, but I'm sure many present-day readers besides myself who were members of the club would be interested to know the story of the club's shutdown. — F. ALLAN HERRIDGE (Basingstoke, Hampshire).

CLUB NEWS *continued from page 78*

PURLEY AND DISTRICT RADIO CLUB
Hon. Sec.: E. R. Honeywood, G3GKF, 105 Whytecliffe Road, Purley, Surrey.

On March 1st, G3OST gave an interesting talk on "Communication Receivers", and on March 15th, a spares sale was held.

SOUTH MANCHESTER RADIO CLUB
Hon. Sec.: M. Barnsley, G3HZM, "Greenways", 11 Cemetery Road, Denton, Manchester, Lancashire.

G3HZM's lecture on March 15th he called "More on a.c. Theory". Later in the month, on the 29th, the annual Hot Pot Supper was held and enjoyed by all who went.

SPEN VALLEY AMATEUR RADIO SOCIETY
Hon. Sec.: L. A. Metcalfe, 1A Moorlands Road, Birkenshaw, Bradford, Yorkshire.

On March 21st, members paid a visit to a nearby electronics firm, and on 4th April "Aerial Problems" were discussed by Mr. A. R. Bailey.

RECEIVERS & COMPONENTS

EXCEPTIONAL VALUE: Picture Tubes, brand new. Mazda 19in., CME1901, Mullard 19in.. AW47-90/91, £4/10/-; Mullard 23in.. AW59/90, £6/10/-; carriage (insured) paid. 12 months' guarantee. Note: All brand new. We also supply most other sizes completely regunned at £4/17/6, guaranteed 12 months. TOMLINS, 156 Lewisham Way, New Cross, SE14. TID 3857.

TR1986 AUXILIARY EQUIPMENT. dual control unit 383 with two 10-way channel sel. S.W. and one 5-way function S.W. 7/6.

Relay unit 123 with 26C4 valves and nine relays enables two TR1986 units to be used as relay station 15/-. Modulator 7477 with six 12AT7, four 6AQ4 valves and one relay. Size 5½in. x 6in. x 7in. Enables TR1936 to be used for homing, 25/-.

TX type 87 with three 3A4, one 1L4 and 1xtal (approx 10Mc/s) output on 60Mc/s complete 15/-, less valves and xtal three for 10/-. AMP433 with three IT4, two IL4 and two crystal diodes complete 10/-, less valves, three for 10/-. TR1920 Tx/Rx 115-145Mc/s complete with 21 valves and one xtal, tested £6. untested £4/10/-.

100B Inverter 24V d.c. input 115V a.c. 400c/s three phase output 30/-. Wanted: SCR522 and SCR269 maintenance manuals, also many others W.H.Y. All items carriage paid. CLARKE, 29 Leighinmonk Avenue, Ballymena, N. Ireland.

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RECEIVERS & COMPONENTS
(continued)

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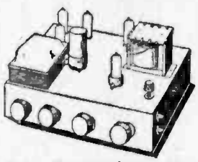

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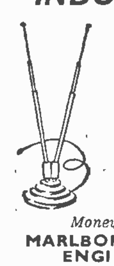

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1R5	5/3	DL94	6/6	PCL83	9/6
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1T4	3/3	EB91	3/-	PENDD4020	
3S4	5/11	EBC41	7/6		17/6
3V4	6/6	EBF80	7/6	PL36	9/6
5U4G	4/6	EBL21	12/-	PL31	8/-
5Y3GT	5/3	ECC40	13/-	PL82	6/-
5Z4G	8/6	ECC81	4/6	PL83	6/-
6K7G	1/9	ECC82	4/6	PL84	8/-
6K8G	4/9	ECC83	6/3	PY31	7/6
6Q7G	5/6	ECC84	7/6	PY32	9/6
6V6G	4/-	ECC85	7/6	PY80	7/-
6X5GT	6/6	ECF80	6/9	PY81	6/3
12K7GT	4/3	ECF82	8/3	PY82	5/9
12K8GT	9/-	ECH42	7/9	PY83	7/-
12Q7GT	4/6	ECL80	6/9	U25	11/-
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DAF91	4/3	EL84	6/3	UCH42	7/6
DAF96	6/9	EY51	6/9	UCH81	7/9
DF33	8/9	EY86	6/9	UCL82	9/3
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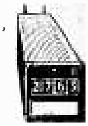

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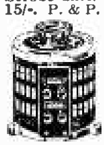

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DK92	7/6
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DL91	8/0
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EF9	21/-
EF22	14/-
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EL33	10/-
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EL35	10/-
EL37	17/6
EL38	17/6
EL41	9/6
EL42	9/6
EL81	12/6
EL84	6/9
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EL90	8/6
EL91	4/-
EL95	10/6
EM80	8/6
EM81	8/6
EM84	9/6
EM85	10/-
EY51	7/6
EY81	8/6

EY83	12/6
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EZ35	6/-
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OZ4	5/6
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PABC80	13/-
PCC84	8/-

PCC85	9/6
PCC88	12/6
PCC89	8/6
PCF80	9/-
PCF82	7/-
PCF84	12/6
PCF86	12/6
PCL82	9/-
PCL83	10/-
PCL84	7/-
PCL85	9/-
PCL86	12/6
PENA4	17/6
PENB4	17/6
PEN4DD	24/-
PEN4VA	17/6
PEN36C	20/-
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PL38	21/-
PL81	9/-
PL82	8/-
PL83	7/6
PL84	8/-
PL820	13/-
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PX4	15/-
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PY32	12/6
PY33	10/6
PY80	7/6
PY81	7/6
PY82	6/9
PY83	8/-
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SP41	3/6
SP61	3/6
T41	15/-
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U10	9/-
U12	9/-
U14	9/-
U22	8/-
U24	21/-
U25	11/-
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U37	17/6
U47	11/-
U50	7/-
U52	4/-
U76	7/6
U78	4/6
U145	10/6
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U281	15/-
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U301	17/-
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U403	10/-
U404	10/-
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UBC41	8/6
UBC81	10/-
UBF80	9/-
UBF89	7/6
UBL21	20/-
UCC84	11/6
UCC85	7/6
UCF80	12/6
UCH21	20/-
UCH42	8/6
UCH81	8/-
UCL82	9/6
UCL83	13/6
UF41	7/6
UF42	7/6
UF80	7/-
UF85	7/6
UF86	12/6
UF89	6/6
UL41	8/-
UL44	20/-
UL46	14/6
UL84	6/6
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UY21	15/6
UY41	7/6
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W61	11/-
W76	5/-
W77	4/-
W81	6/-
W81M	6/-
X41	15/-
X61M	10/-
X65	12/6
X76	12/6
X76M	12/6
X78	26/-
X79	40/9
X81	10/-
Y61	10/-
Y63	10/-
Z63	7/6
Z66	10/-
Z77	4/-
Z152	5/-
OZ4	5/-
1A7	11/-
1C5	10/-
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1D6	10/-
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1N5	9/6
1R5	6/-
1S4	8/-
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2P	24/9
3A4	5/-
3A5	10/6
3Q4	8/-
3Q5	9/-
3S4	6/-
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6AT6	6/-
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6B8G	3/-
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6BE6	6/-
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6BQ7A	12/6
6BR7	10/6
6BS7	12/6
6BW6	8/-
6BW7	5/-
6C4	3/6
6C5GT	8/-
6C6	6/6
6C9	12/6
6CD6G	27/6
6CH6	10/-
6CW4	16/-
6D2	4/-
6D6	5/6
6E5	10/-
6F1	10/6
6F6	6/9
6F12	4/-
6F13	10/-
6F14	10/-
6F15	12/6
6F19	12/6
6F23	10/6
6F25	16/6
6F26	13/6
6F33	5/6
6H6	2/-
6J5	5/6
6J5G	4/6
6J5GT	5/-
6J7	7/6
6J7G	5/-
6J7GT	7/6
6K7	7/6
6K7G	2/-
6K7GT	7/6
6K8	9/6
6K8G	5/-
6K8GT	9/6
6K25	17/6
6L1	10/-
6L6	7/6
6L7	10/-
6L18	10/-
6L19	15/-
6N7GT	[illegible]/6

6P25	10/6
6P28	12/6
6Q7	9/6
6Q7G	6/6
6Q7GT	8/6
6SA7	7/-
6SC7	8/6
6SF5	10/-
6SG7	7/-
6SH7	6/-
6SJ7	6/6
6SK7	5/6
6SL7GT	6/-
6SN7GT	5/6
6SQ7	8/6
6U4GT	10/-
6U5G	7/6
6V6G	4/6
6V6GT	8/-
6X4	4/6
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7C5	8/-
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7D5	15/-
7D6	15/-
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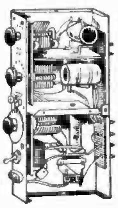

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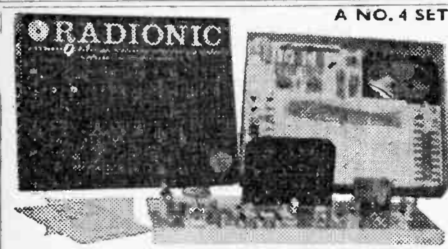

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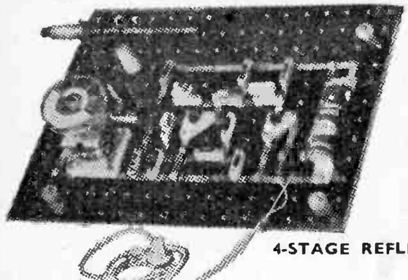

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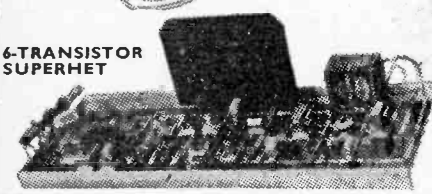

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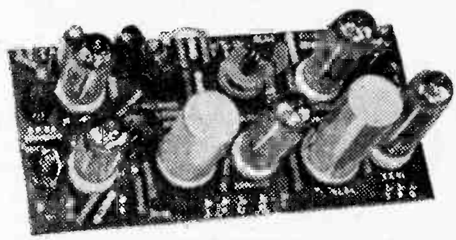

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PRACTICAL WIRELESS, MAY, 1963

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